ABSTRACTS OF NORTH AMERICAN GEOLOGY

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UNITED STATES DEPARTMENT OF THE INTERIOR

WALTER J. HICKEL, *Secretary*

GEOLOGICAL SURVEY

William T. Pecora, *Director*

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ABSTRACTS OF NORTH AMERICAN GEOLOGY

INTRODUCTION

Abstracts of North American Geology contains abstracts of technical papers and books and also citations of maps on the geology of North America including Greenland, the West Indies, as well as the State of Hawaii, Guam, and other island possessions of the United States. Articles of a general nature by North American authors are cited even though published in foreign journals but those by foreign authors are included only if they appear in North American journals. Abstracts are prepared only of material that is believed to be generally available. Ordinarily abstracts are not published of material with small circulation (such as dissertations, open-file reports of memorandums) or of other papers presented orally at meetings.

The Abstracts is an additional reference tool but does not replace the Bibliography of North American Geology, which has been published by the Geological Survey since 1887. Twelve monthly issues of Abstracts of North American Geology are published each year. The Bibliography includes citations and subject index for a calendar year.

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Cranbrook Inst. Sci. Bull.—Cranbrook Institute of Science Bulletin. Bloomfield Hills, Mich.

Dissert. Abs. Internat.—Dissertation Abstracts International. University Microfilms. Ann Arbor, Mich.

Geobios—Geobios. Paléontologie, stratigraphie, paléoécologie. Publié avec le concours du Centre National de la Recherche Scientifique. Edité par le Departement des Sciences de la Terre, Faculté des Sciences, Université de Lyon. Lyon, France.

Geoscience Inf. Soc. Proc.—Proceedings of the Geoscience Information Society. American Geological Institute. Washington, D.C.

Jour. Radioanal. Chemistry—Journal of Radioanalytical Chemistry. An international journal dealing with all aspects of nuclear analytical methods. Elsevier Publishing Company, Amsterdam, Netherlands, and Akedémiai Kiado. Budapest, Hungary.

Mineralog. et Petrog. Acta—Mineralogica et Petrographica Acta. Istituto di Mineralogia e Petrografia dell'Università di Bologna. Bologna, Italy.

New Phytologist—The New Phytologist. Blackwell Scientific Publications. Oxford, England, and Edinburgh, Scotland.

Ocean Eng.—Ocean Engineering. An international journal. Pergamon Press. New York, N. Y., and London, England.

Palaeovertebrata—Palaeovertebrata. Revue trimestrielle de paléontologie des vertébres, publiée avec le concours de la Faculté des Sciences de Montpellier et de la Société Méridionale pour l'Expansion de la Recherche Scientifique. Montpellier, France.

Soc. Sci. Fennica Årsb.—Societas Scientiarum Fennica Årsbok. Helsinki, Finland.

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ABSTRACTS

Adent, William A. *See* Szasz, Stephen E. 04901

04708 **Agterberg, F. P.** Interpolation of areally distributed data, *in* Operations research and computer applications in the mineral industries: Colorado School Mines Quart., v. 64, no. 3, p. 217-237, illus., 1969.

The following mathematical techniques for interpolation and filtering of areally distributed data in geology and mining are summarized: (1) Fourier transforms, (2) harmonic trend surfaces, (3) 2D-power spectrum, (4) 2D-autocovariance function, (5) 2D-autocorrelation function, (6) filtering by weighted moving average schemes, and (7) fitting of sine surfaces. —KAF

Ahmed, F. R. *See* Barnes, W. H. 04402

04811 **Akin, Ralph H., Jr.; Graves, Roy W., Jr.** Reynolds oolite of southern Arkansas: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 1909-1922, illus., table, 1969.

The Reynolds oolite, the upper member of the Smackover Formation of Jurassic age in southern Arkansas, is a widespread carbonate unit. The Reynolds includes five facies and the patterns of local changes are analogous with distribution patterns of carbonate sediments now being deposited in the Bahama Islands. The Buckner Formation, which overlies the Smackover, is largely evaporitic and nonmarine. Lateral changes in the Buckner lithology parallel facies changes in the Reynolds oolite. —*from* Authors' abstract

04796 **Albanese, John P.** Resume of Wyoming archeology: Earth Sci. Bull., v. 2, no. 2, p. 17-25, illus., 1969.

Man evolved in Africa between one and two million years ago, was living in Europe and Asia at least 300,000 years ago, but first entered North America 20,000-45,000 years ago. Some sites in the west have been estimated to be 40,000 years old. Artifacts of the Clovis and Folsom cultures and Plano Complex are described and illustrated, as well as some more recent ones. —ESL

Albee, A. L. *See* Knowles, C. R. 04986

Alcock, Richard. *See* Wager, Robert E. 04849

Alexander, Shelton S. *See* Phinney, Robert A. 04448

04403 **Allard, G. O.; Simmons, W. B., Jr.** Blastopoikilitic textures in gabbroic metaanorthosite of the Dore Lake Complex, Chibougamau [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 126, 1969.

04472 **Allen, Alice S.** Geologic settings of subsidence, *in* Reviews in engineering geology, V. 2 (D. J. Varnes and George Kiersch, editors): Boulder, Colo., Geol. Soc. America, p. 305-342, illus., 1969.

This paper reviews the role of geologic processes that contribute to subsidence. The processes are: (1) solution of gypsum and salt and redistribution of transient fill materials through solution cavities in calcareous rocks, (2) underground erosion of uncemented or lightly cemented silt and sand through temporary underground passageways, (3) lateral plastic flow of salt, gypsum and anhydrite, shale, and clay

under loading, (4) compaction of sediments by loading, drainage, vibration, and hydrocompaction, (5) tectonic movements including primary and secondary effects of earthquakes, folding, and warping, and (6) volcanic activity. Examples have been selected to illustrate subsidence under natural and manmade conditions. The future prospects for advancing our geologic knowledge are excellent. Methods of measuring ground-surface displacements are improving rapidly. —*from* Author's abstract

04424 **Allen, J. R. L.** The maximum slope-angle attainable by surfaces underlain by bulked equal spheroids with variable dimensional ordering: Geol. Soc. America Bull., v. 80, no. 10, p. 1923-1930, illus., 1969.

A theoretical model is advanced for the maximum slope angle on the supposition that the average properties of haphazard arrangements of spheroidal particles can be represented by a combination of two different regular packings in a proportion to give the original concentration. The tangent of the yield angle is linearly proportional to spheroid concentration, which depends on the axial ratio. The dimensional ordering of the particles can be either dependent upon or independent of concentration. The equations differ slightly, and only in their constants, according to the choice of the ordering. Because of the influence of shape and ordering, it is inadmissible to apply yield angle models based on spheres to natural ellipsoidal particles. The equations developed are relevant to the slope angles of screes, talus, ripples and dunes. —*from* Author's abstract

Allman, David W. *See* Williams, Roy E. 04718

Al-Rawi, Yehya. *See* Christensen, M. N. 04600

Amerman, C. R. *See* Jamieson, D. G. 04724

Ames, H. T. *See* Traverse, A. 04581

Amiel, S. *See* Mantel, M. 04617

04907 **Andersen, E. Krogh; Danö, Marianne; Petersen, O. V.** A tetragonal natrolite, *with a chemical analysis* by M. Mouritzen: Medd. Grönland, v. 181, no. 10, 19 p., illus., tables, 1969; *reprinted as* Grönlands Geol. Undersögelse Bull. 79, 1969; Copenhagen Univ. Mineralog. and Geol. Mus. Contr. Mineralogy 69, 1969.

Tetragonal natrolite occurs as white or dull pink microcrystalline sheaflike aggregates of prismatic crystals, bounded by basal pinacoid or bipyramid, in hydrothermal veins in naujaite at Ilímaussaq. Density is 2.210±0.002. The mineral is uniaxial, optically positive. $n_{epsilon} = 1.493 \pm 0.001$, $n_{omega} = 1.480 \pm 0.001$. DTA and TGA curves show that tetragonal natrolite dehydrates at a slightly lower temperature than ordinary natrolite. Space group is probably $I\bar{4}2d$. Unit cell dimensions are: $a_0 = 13.043 \pm 0.001$ A, $c_0 = 6.619 \pm 0.001$ A, and Vol. = 2252 A^3. Chemical composition falls within the range of composition of natrolites as reported in the literature. —*from* Authors' abstract

Andersen, F. *See* Caner, B. 04686

Anderson, C. F. L. *See* Gordon, G. E. 04614

Anderson, Daniel G. *See* Robinove, Charles J. 04812

04861 **Anderson, Don L.** The evolution of terrestrial-type planets: Appl. Optics, v. 8, no. 7, p. 1271-1277, illus., 1969.

The internal configuration of the Earth shows that it is an extremely differentiated body, and ages of surface rocks indicate that this differentiation took place early in its history. Gravitational energy associated with formation of the Earth and thermal energy of core formation are primary sources of energy for melting and subsequent gravitational separation into a core, crust, chemically inhomogeneous mantle, and atmosphere and hydrosphere. The larger the planet, the more likely it is to be exten-

sively differentiated and outgassed. The Earth probably accreted in 10^8 yr or less; this causes initial temperatures to be high and results in core formation essentially simultaneous with accretion. —*from* Author's abstract

04487 **Anderson, Jay Earl, Jr.** Development of snowflake texture in a welded tuff, Davis Mountains, Texas: Geol. Soc. America Bull., v. 80, no. 10, p. 2075-2079, illus., 1969.

Snowflake texture consists of more or less randomly oriented laths of alkali feldspar poikilitically enclosed by small patches of optically continuous silica, commonly alpha-quartz. The texture results from devitrification of glassy, densely welded tuff but not, apparently, from devitrification of glassy lava-flow rocks. During devitrification, alkali feldspar crystallizes first, followed by silica; iron oxide minerals become concentrated around the peripheries of devitrified regions. —Author's abstract

04866 **Andrews, J. R.** A kimberlite dyke in the Nigerdlikasik area, Frederikshaab district, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 35-37, 1969.

A dike 50 cm wide, vertical, and traceable for 500 meters, occurs near the Nigerdlikasik area; it is coarse-grained and bears local and exotic inclusions. The matrix consists of xenocrysts of fresh olivine lying in a carbonated serpentine/chlorite groundmass; fresh phlogopite is always present. The inclusions are ultrabasic nodules, nodules with deep crustal mineralogy, and a series of more angular blocks of local country rock. —HRC

04687 **Andrews, J. T.; Falconer, G.** Late glacial and post-glacial history and emergence of the Ottawa Islands, Hudson Bay, Northwest Territories—Evidence on the deglaciation of Hudson Bay: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1263-1276, illus., table, 1969.

The earliest recorded glacial movement in the Ottawa Islands was toward the northeast, the final movement being toward the west-southwest. The islands were deglaciated between 7610 and 7250 years B.P. The marine limit is 158 m above sea level. The deltaic deposits below the marine limit correlate with glacial advances in eastern Canada, and with palynological results from Keewatin, suggesting that they reflect climatically induced processes rather than balance in eustatic-isostatic movements. Curves of emergence drawn from radiocarbon dates on shells agree well with predicted curves. Rates of uplift were about 0.06 m/yr^{-1} at 6500 B.P., whereas the present rate is about 0.008 m/yr^{-1}. The deglaciation of Hudson Bay was marked by the splitting of the ice sheet along the submarine deep that trends southward between Mansel and Coats Islands toward the southwest coast of the bay. —*from* Authors' abstract

04803 **Andrews, J. T.; Webber, P. J.** Lichenometry to evaluate changes in glacial mass budgets—As illustrated from north-central Baffin Island, N.W.T.: Arctic and Alpine Research, v. 1, no. 3, p. 181-194, illus., 1969.

Direct measurement of the growth of *Alectoria miniscula* over 4.3 growing seasons were made. Detailed lichen sampling in two formerly glacierized valleys allows isophyses to be drawn for specific diameters of *A. miniscula*. The gradients of the isophyses are similar to those of lateral glacial features. These reconstructions define ice margins about A.D. 1650 to the present time and enable glacier changes in length, area, and volume to be estimated for the Lewis and Pintail glaciers. Local differences in the trend of the area or volume loss are explained by differences in deglacial history. Specific ablation for the expanded Lewis glacier below the 500 m ice contour averaged about 1.5 m ice equivalent per year, a value not dissimilar to those determined on the present glacier of about 1.3 m ice equivalent. —*from* Authors' abstract

04824 **Andrews, J. T.** The shoreline relation diagram—Physical basis and use for predicting age of relative sea levels (evidence from Arctic Canada): Arctic and Alpine Research, v. 1, no. 1, p. 67-78, illus., tables, 1969; correction, ibid., no. 3, p. 221-222, illus., table, 1969.

A shoreline relation diagram for Arctic Canada is constructed from the equation of the form of postglacial uplift. This operation in itself indicates that the shoreline relation diagram represents a valid concept. The diagram is then used to predict the age and elevation of marine limits, glacial lake strandlines, and lower relative sea levels. A comparison of predicted and observed values suggests that the shoreline relation diagram presented in the paper functions efficiently as a chronological forecaster that can complement and extend late-glacial and postglacial chronologies. The workings of the diagram are such that a few selected radiocarbon dates can be used to establish an extensive and detailed chronology. —Author's abstract

Andrews, John T. *See* Bryson, Reid A. 04825

04669 **Aramaki, Shigeo; Moore, James G.** Chemical composition of prehistoric lavas at Makaopuhi Crater, Kilauea Volcano, and periodic change in alkali content of Hawaiian tholeiitic lavas [with Japanese abs.]: Tokyo Univ. Earthquake Research Inst. Bull., v. 47, pt. 2, p. 257-270, illus., tables, 1969.

The K_2O/Na_2O ratio and, to a lesser degree, $Na_2O + K_2O$ of prehistoric tholeiitic lavas exposed on the wall of Makaopuhi crater, Kilauea Volcano, show periodic change with time. Similar variation is found in the lower member of Waianae Volcano, Oahu Island. Marked increase in the K_2O/Na_2O ratio of the historic lavas of Kilauea as compared with that of early historic and many prehistoric lavas of the same volcano may correspond to a part of such periodic variations in the ratio as represented by the above two examples. As one possible mechanism for such increase in ratio, fractional crystallization of K_2O-poor plagioclase is proposed. —*from* Authors' abstract

04940 **Armstrong, C. A.** Geology and ground water resources of Burke and Mountrail Counties—Pt. 2, Ground water basic data: North Dakota Geol. Survey Bull. 55 (North Dakota Water Comm. County Ground Water Studies 14), pt. 2, 282 p., illus., tables, 1969.

Data collected mainly between 1965 and 1968 for Burke and Mountrail Counties functions as a reference for part 1 (geology) and part 3 (ground-water resources) of this report. Information consists of: (1) data on about 2,100 wells and test holes, (2) data on 58 springs, (3) water-level measurements in 63 observation wells, (4) logs of about 570 test holes and selected wells, and (5) chemical analyses of 504 water samples. Extrapolations based on these data should be conservative because of the irregular distribution of water-bearing rocks. —MCM

04461 **Armstrong, Richard Lee.** K-Ar dating of laccolithic centers of the Colorado Plateau and vicinity: Geol. Soc. America Bull., v. 80, no. 10, p. 2081-2086, illus., table, 1969.

Two episodes of igneous activity occurred on the Colorado Plateau during Phanerozoic time. Laccolithic centers whose ages cluster about the Cretaceous-Tertiary boundary occur along the projection of the Laramide mineral belt of Colorado as far southwest as the Carrizo Mountains. Laccolithic and mafic volcanic centers of mid-Tertiary age occur scattered about, and on the edges of, the Plateau Province, and in some areas mafic volcanism continues today. Both pyroxene and hornblende separates consistently gave anomalously old K-Ar dates. It was thus necessary to analyze whole-rock samples from which the mafic minerals were removed to obtain age determinations that did not conflict with stratigraphic relations. —Author's abstract

04569 **Arnold, R. G.** Pyrrhotite phase relations below 304 ± 60°C at <1 atm total pressure: Econ. Geology, v. 64, no. 4, p. 405-419, illus., tables, 1969.

Hexagonal pyrrhotite coexisting with FeS has the following compositions in percent atomic Fe: 47.85 at 25°C, 48.57 at 105°C, and 49.67 at 140°C. Natural assemblages containing these phases have generally attained equilibrium at earth-surface temperatures. The compositions of coexisting hexagonal and monoclinic pyrrhotite at or below 304 ± 6°C are judged to be about 47.20 and 46.75 atomic percent Fe, respec-

tively. Anomalous behavior suggests metastability of the monoclinic form. Abundance of natural monoclinic pyrrhotite with pyrite or with hexagonal pyrrhotite plus pyrite probably indicates heating above 304°C. —WSW

04608 **Asthana, Virendra.** The Mt. Simon Formation (Dresbachian Stage) of Wisconsin [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 252B, 1969.

Athavale, V. T. *See* Parekh, P. P. 04627

04930 **Aumento, F.** Diorites from the Mid-Atlantic Ridge at 45°N.: Science, v. 165, no. 3898, p. 1112-1113, illus., tables, 1969.

Diorites, associated with basalts, basalt breccias, and serpentinized peridotites, occur in place on the fault scarps of two seamounts from the western High Fractured Plateau of the Mid-Atlantic Ridge at lat 45° N. Specimens are angular, show outer weathering zones, and have thick ferromanganese crusts, the thickness of which indicate exposure to ocean water well before Pleistocene ice ages, probably during final upthrusting of seamount blocks. Relatively recent vertical movements of the crust therefore may have taken place in these areas remote from the axis of the ridge. The concordant ages, isotopic compositions, and chemistry and physical appearance of the diorites is strong indication that they occur in place and are directly related to associated igneous rocks. Their in-place occurrence on these seamounts is proof that magmatic differentiation has progressed farther than is generally thought possible in midocean ridge environments. —GV

Back, William. *See* Hanshaw, Bruce B. 04565

Baedecker, P. A. *See* Gordon, G. E. 04614

04888 **Bailey, Robert G.; Rice, Raymond M.** Soil slippage—An indicator of slope instability on chaparral watersheds of southern California: Prof. Geographer, v. 21, no. 3, p. 172-177, illus., table, 1969.

Soil slips, small landslides involving only the material above unweathered bedrock, are a major erosional agent, often associated with high-volume storms, and may strip up to 10 percent of the area of soil. Natural features of the terrain and climate in the San Gabriel Mts., Calif., are conducive to high rates of erosion. Bedrock is a deeply weathered and highly fractured igneous-metamorphic complex, and shallow rocky soils rest on slopes exceeding the angle of repose. The effectiveness of chaparral in controlling soil movement varies with burn history. Experimental studies show that both the number of slips and the area affected are five times greater on grass-covered areas than on comparable chaparral areas. The Bell Canyon watersheds were mapped and studied for slope and surface drainage, vegetation, soil properties, erosion rates, and geomorphic implications. —ESL

Baker, B. L. *See* Hodgson, G. W. 04589

04413 **Baldwin, E. M.** Thrust faulting along the lower Rogue River, Klamath Mountains, Oregon: Geol. Soc. America Bull., v. 80, no. 10, p. 2047-2052, illus., 1969.

The Dothan Formation, a thick sandstone unit of the northern Klamath Mountains in Oregon, is of undetermined age owing to its lack of fossils and uncertain stratigraphic position. The Galice Formation, a more argillaceous unit of Oxfordian and Kimmeridgian age, is underlain with apparent conformity by the volcanic Rogue Formation. The Dothan Formation is also underlain by a similar volcanic unit. The writer proposes that the Dothan and Galice Formations are contemporaneous facies deposited in different parts of the basin and that they and the underlying Rogue Formation have been placed in juxtaposition by thrusting from the southeast. —Author's abstract

Ball, Arthur. *See* Shute, John. 04923

04794 **Baisley, John K.; Stokes, William Lee.** Unusual coprolites from the Upper Cretaceous Ferron Sandstone, east-central Utah: Earth Sci. Bull., v. 2, no. 2, p. 5-6, illus., 1969.

Large coprolites of unusual shape (illustrated and decribed in detail) are composed of 80 percent calcite and 20 percent clay. Data indicate that the fecal material was deposited by a large fish or marine reptile that preyed on soft-bodied benthonic organisms. —ESL

Baltosser, R. W. *See* Lawrence, H. W. 04952

05001 **Barker, Daniel S.; Long, Leon E.** Feldspathoidal syenite in a quartz diabase sill, Brookville, New Jersey: Jour. Petrology, v. 10, no. 2, p. 202-221, illus., tables, 1969.

Formation of nepheline- and analcime-bearing syenite at the upper contact of the quartz diabase sill is attributed to assimilation reactions between silica-poor, sodium-rich Triassic argillite and crystallizing granophyre derived by fractional crystallization of basaltic magma. Field relationships, isotopic data, and results of petrographic, experimental, and chemical investigations support this conclusion and controvert alternative hypotheses of syenite formation by separate intrusion, xenolithic origin, differentiation from diabasic magma, or partial fusion and mobilization of the argillite. —MS

04422 **Barnes, Ivan; O'Neil, James R.** The relationship between fluids in some fresh Alpine-type ultramafics and possible modern serpentinization, western United States: Geol. Soc. America Bull., v. 80, no. 10, p. 1947-1960, tables, 1969.

Calcium hydroxide water issues from four fresh but partly serpentinized Alpine-type ultramafic bodies, three in California, one in Oregon. The calcium hydroxide water is unsaturated with Mg end-member olivine and pyroxene, supersaturated with Mg end-member brucite and serpentine, has chemical potential to cause serpentinization and is isotopically similar to the magnesium bicarbonate water of meteoric origin commonly associated with ultramafic rocks and serpentinites in western United States. Field relations and geochemical arguments imply that some serpentinization is presently taking place in near-surface environments; loss of CaO is the main compositional change related to this serpentinization. —JHF

04402 **Barnes, W. H.; Ahmed, F. R.** A note on the unit cell constants, and X-ray diffraction powder pattern, of pyrobelonite: Canadian Mineralogist, v. 10, pt. 1, p. 117-123, tables, 1969.

The unit cell dimensions of pyrobelonite have been remeasured using a Picker automatic diffractometer and Cu radiation. New data are: orthorhombic, Pnam, a = 7.644, b = 9.508, c = 6.182 Z; U = 449.3025 A^3, F. W. = 1576.30; $D_x = 5.824$ g ml^{-1}; A = 4; $D_m = 5.82$ g ml^{-1}. Dimensions previously reported are compared with remeasured values in a table. Indexed X-ray diffraction powder data with d values calculated on a computer are listed in a table. —VSN

04451 **Barosh, Patrick J.** Use of seismic intensity data to predict the effects of earthquakes and underground nuclear explosions in various geologic settings: U.S. Geol. Survey Bull. 1279, 93 p., illus., tables, 1969.

The variable principally responsible for range of intensities at any given epicentral distance is the geologic environment. Microregionalization maps, showing relative intensities for different geologic settings, could be used with intensity-epicentral-distance curves for a particular geologic setting to predict intensity, at a given point of known ground type, from an earthquake of given magnitude, epicentral distance, and focal depth, and also to estimate potential seismic effects on manmade structures from nuclear explosions. The relation between nuclear-explosion energy and earthquake magnitude and between intensity and focal depth must be sufficiently well known to permit extrapolation of earthquake data to the shallow depths and energy releases of nuclear explosions. Preliminary equations, showing these relations, exist. —*from* Author's abstract

Barsdate, Robert J. *See* Forbes, Robert B. 04571

04756 **Barth, Thomas F. W.** Feldspars: New York and London, Wiley-Interscience, 261 p., illus., tables, 1969.

All available data on feldspar are collected and discussed here for the first time; description of determinative methods are deliberately omitted. X-ray methods are commonplace but optical methods are more specialized and have a long tradition and hence the literature on the subject is very large. Chapter headings are: general mineralogy and classification of rock-forming feldspars, survey of pseudosymmetry and twinning, structures of feldspars, physical properties of feldspars, thermodynamic properties of feldspars, and historical notes and old names. A bibliography, and author and subject indexes are appended. —MCM

04906 **Barton, Randolph, Jr.** Refinement of the crystal structure of buergerite and the absolute orientation of tourmalines: Acta Cryst., v. B25, pt. 8, p. 1524-1533, illus., tables, 1969.

The crystal structure of buergerite from Mexico has been refined by least squares using X-ray intensity data; it crystallizes in *R3m*, and hexagonal cell dimensions are $a = 15.869 \pm 2$, $c = 7.188 \pm 1$ A at 21°C. $D_m = 3.30 \pm 1$ at 23°C; with $Z = 3$, $Dx = 3.29$ g $\times$ cm^{-3}. Residual R for the observed reflections is 0.046. The structure is similar to the refined dravite structure, used as the starting model. Some ferric iron replaces octahedral Al in the 18(*c*) position, a substitution not required by the chemical analysis. The absolute orientation of the crystal structure with respect to macroscopic polar properties of tourmaline was determined by anomalous dispersion under copper radiation. The SiO_4 tetrahedra point toward the analogous pole of the *c* axis, the pole that becomes positively charged on heating. —*from* Author's abstract

04991 **Bascom, Willard.** Technology and the ocean: Sci. American, v. 221, no. 3, p. 198-217, illus., 1969.

This popular article reviews nonmilitary technological advances in oceanography over the past decade. The five most important developments are (1) the supertanker capable of carrying more than 300,000 deadweight tones, (2) the deep-diving submarine, (3) the ability to drill in deep water, (4) the ability to navigate precisely, and (5) the ability to examine the ocean bottom in detail from the surface by means of television and side-looking sonar. —DWR

Bassett, W. A. *See* Takahashi, Taro. 04932

Bayliss, P. *See* Deere, R. E. 04913

04723 **Beatty, R. M.** Grady Kirby (1889-1969): Am. Assoc. Petroleum Geologists Bull., v. 53, no. 10, p. 2198-2199, portrait, 1969.

Bebout, D. G. *See* Maiklem, W. R. 04833

Beck, Ray H. *See* Jacka, Alonzo D. 04482

04732 **Beers, Armand; Parry, W. T.** Regional geochemistry of the Oquirrh Mountain soils [abs.]: Mining Eng., v. 21, no. 8, p. 43, 1969.

04754 **Bell, W. A.** Catalogue of types and figured specimens of fossil plants in the Geological Survey of Canada collections (megaplant supplement 1963-67): Ottawa, Ontario, Geol. Survey Canada, 36 p., 1969.

This supplement to the comprehensive catalog of types published in 1962 (Bell) comprises an index of types and figured specimens in collections of the Survey that were established from 1963-67; it includes some original types established from new collections of megaplants, but also many hypotypes selected from collections not previously included in the Survey type collections. Types and figured specimens of miospores have not been included because a separate publication was considered more convenient for palynologists and stratigraphic geologists. —MCM

Bence, A. E. *See* Knowles, C. R. 04986

04826 **Benedict, James B.** Microfabric of patterned ground: Arctic and Alpine Research, v. 1, no. 1, p. 45-48, illus., 1969.

The orientation of elongate sand grains in patterned-ground can be determined by impregnating soil samples with plastic and measuring grain orientations in thin section. Microfabric studies of two earth hummocks in the Colorado Front Range suggest that the technique is applicable to problems of patterned-ground origin. —Author's abstract

Bennett, Harold J. *See* Johnson, Edward E. 04707

04567 **Berner, Robert A.** The synthesis of framboidal pyrite: Econ. Geology, v. 64, no. 4, p. 383-384, illus., 1969.

Pyrite, in the form of framboidal microspheres, has been synthesized in the laboratory at low temperature (65°C) and neutral pH by the reaction of FeS with elemental sulfur in saturated H_2S solution. The results indicate that the direct action of microorganisms is not necessary for the formation of framboidal texture. —Author's abstract

04604 **Berner, Robert A.** Chemical changes affecting dissolved calcium during the bacterial decomposition of fish and clams in sea water: Marine Geology, v. 7, no. 3, p. 253-274, illus., tables, 1969.

Bacterial decomposition in the laboratory of butterfish, smelts, and *Mya* and *Venus* clams in the presence of $CaCO_3$ over periods of 65 to 250 days, results in a slow rise in the pH of sea water in contact with the decaying organisms due to formation of ammonia and other nitrogenous bases from breakdown of proteins and other nitrogen-containing biochemical compounds. In the case of butter fish and smelts, rise in pH brings precipitation of dissolved calcium as calcium fatty acid salts or soaps in the range C-14 to C-18; no $CaCO_3$ forms. In the case of clams, dissolved calcium precipitates during pH rise only where there is extensive bacterial sulfate reduction. Large amounts of acids other than carbonic are generated during decomposition of *Venus*; in absence of $CaCO_3$ this results in very low pH which does not subsequently rise. —*from* Author's abstract

04671 **Bhatnagar, V. M.** Anion substitutions in lead apatites [with German abs.]: Zeitschr. Anorg u. Allg. Chemie, v. 367, nos. 5-6, p. 289-292, illus., 1969.

The XO_4^{3-} group in lead apatites has lower symmetry. Replacement of Ca^{++} by Pb^{++} in the apatite structure shifts the γ_3 and γ_1 vibrations to lower frequencies. —Author's abstract

04899 **Bick, Kenneth F.; Coch, Nicholas K.** Geology of the Williamsburg, Hog Island, and Bacons Castle quadrangles, Virginia: Virginia Div. Mineral Resources Rept. Inv. 18, 28 p., illus., tables, geol. maps, 1969.

Coastal plain sediments in these quadrangles range in age from Miocene to Pleistocene. The St. Mary's and Yorktown Formations, shallow-water marine and littoral, are unconformably overlain by unfossiliferous gravels, sands, silts and clays, with complex cut-and-fill relationships. The fluvial-glacial Sedley and fluvial Bacons Castle formations are Pliocene-Pleistocene; the estuarine-littoral Windsor and fluvial-estuarine Norfolk formations are Pleistocene, tentatively Yarmouth and Sangamon, respectively. Post-Miocene formations are in four dissected plains separated by scarps, at 120-, 90-, 70-, and 45-ft elevations in order of decreasing age. Their episodes of aggradation and degradation coincide with interglacial stages; maximum sea level was at + 100 to 110 feet during Windsor deposition and + 45 to 50 feet during Norfolk deposition. —GDC

04897 **Bigelow, Gordon E.** Distribution and characteristics of dikes in the southeast part of the Koolau Range, Oahu: Pacific Sci., v. 23, no. 4, p. 496-506, illus., table, 1969.

Exposed dikes and sills trending southwest and roughly perpendicular to the primary Koolau rift zone in the Waialae-Palolo area of Oahu are hypersthene-bearing tholeiitic rocks, intrusive equivalents of the Koolau Series basalt flows. No Honolulu Series intrusives were located along a line joining Kaau Crater, Mauumae, Kaimuki, and Diamond Head, a secondary rift of the Koolau volcano. Mineralogy of the Koolau intrusives displays a striking chemical and morphological constancy. Feldspar crystals in these rocks show antipathy to ore inclusions. Cumuloporphyritic texture is strongly developed and may be related to flow patterns evident in groundmass materials.—Author's abstract

04568 **Billings, Gale K.; Kesler, Stephen E.; Jackson, Stewart A.** Relation of zinc-rich formation waters, northern Alberta, to the Pine Point ore deposit: Econ. Geology, v. 64, no. 4, p. 385-391, illus., tables, 1969.

Brine samples from the Presqu'ile conduit 350 km downdip (southwest) of the Pine Point orebody have a composition similar to analyzed inclusion fluids from Mississippi Valley-type deposits, and bottom-hole temperatures are similar to the fluid-inclusion filling temperatures. The brine now flowing eastward through the Presqu'ile conduit alone, assuming dimensions of 350 × 60 km, contains enough zinc to form a deposit half the size of Pine Point. The shales in the Western Canada basin, south of Pine Point, contain 3000 times as much zinc, in easily leachable form, as is contained in the Pine Point orebody.—WSW

04953 **Birdseye, Henry S.** Geothermal power resources in the Southwest, *in* Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, p. 86-96, illus., 1969.

Geothermal power prospecting includes detailed geologic mapping, geochemical surveying (inasmuch as much of the water is detectable chemically), and geophysical surveying (by detecting anomalies with very sensitive heat-sensitive devices). The geothermal areas of the world are confined to volcanic regions which have undergone faulting. In the United States, such fault controlled areas are found in Utah and New Mexico. In Utah, hyperthermal occurrences are, for the most part, in proximity to the state's north-trending fault systems and are closely related to Cenozoic igneous rocks. Hot springs are common in Nevada also along north-trending fault lines. Numerous thermal anomalies occur in New Mexico in the Rio Grande structural trough, and some in smaller troughs west of the Rio Grande.—HRC

04979 **Birkelund, B.; Perch-Nielsen, K.** Field mapping in upper Palaeozoic and Mesozoic sediments of Scoresby Land and Jameson Land, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 53-57, table, 1969.

Special attention is given to the comparison of the lithology of the different formations in the western and eastern parts of the Jameson Land basin. Upper Paleozoic rocks are exposed in the western and eastern borders of the basin, while the central part is covered by Triassic and Jurassic rocks. Tertiary dikes and sills occur throughout the region, and faults of mainly Tertiary age generally strike N-S and caused folding of incompetent layers in the Triassic Wordie Creek Formation near Werner's Bjerge, a Tertiary intrusive massif in the northwestern part of the area.—HRC

04765 **Bishop, Donald T.** Stratigraphy and distribution of basalt, Benewah County, Idaho: Idaho Bur. Mines and Geology Pamph. 140, 20 p., illus., geol. map, 1969.

The plateau west of Benewah County is formed by consolidation of numerous basalt flows of the Columbia River Group. Lobes of basalt extended into stream valleys in the western and central parts of the county. Three formations of basalt flows and interbedded sedimentary rocks have been mapped; the lower two correlate with the Yakima Basalt of Washington. The Pliocene Unit C, of local origin, underlies a broader area, and the flows are associated with laharic breccias. Mineralogy of the three units is described. When major valleys were blocked by flows, lacustrine material was deposited, and covered by later flows, with pillow complexes in the ponded areas. Regional tilting of about 10 feet per mile is indicated.—*from* Author's abstract

04342 **Blackburn, W. H.; Dennen, W. H.** Harrisitic structure in the gabbro at Nahant, Massachusetts [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 126-127, 1969.

04610 **Blake, Jerry Wayne.** Hydrothermal shale and clay-iron compound studies [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 313B, 1969.

Blavier, P. *See* Kermabon, A. 04751

Bohse, H. *See* Brooks, C. K. 04976

Bolyard, Dudley W. *See* Johnson, Ross B. 05008

04875 **Bondesen, E.** Research on the high-metamorphic complexes of the Agto area, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 25-26, 1969.

The rocks are largely migmatitic gneisses and amphibolites in granulite and amphibolite facies. There are also some metasedimentary rocks, always occurring synformally. The regional structural pattern is to a varying degree controlled by ENE- to NE-trending fold axes and steeply NW-dipping axial planes; only the ENE pattern contains the metasediments and is in general parallel with the Nagssugtoqidian fold belt. Rectilinear, faulted but not folded dikes of N-S and E-W trends, metamorphosed to granulite facies, occur only in the N-S- or nearly N-S-trending structures. Other details of field work are described. —HRC

04851 **Bonnichsen, Bill.** Geology of the southern part of the Duluth Complex, Minnesota, *in* Mining Symposium, 30th Ann., and AIME, Minnesota Sec., 42d Ann. Mtg., Duluth, Minn., 1969: Minneapolis, Minn., Univ. Minnesota, School Mineral and Metall. Eng., p. 89-93, illus., 1969.

Two groups of intrusive igneous rocks are abundant in the southern Duluth Complex: (1) earliest is the Anorthositic Series consisting primarily of gabbroic and troctolitic anorthosite; mafic minerals are paragenetically later than the plagioclase; (2) the latest group is the Troctolitic Series in which troctolite and augite troctolite are most common; plagioclase and olivine are contemporaneous, and paragenetically earlier than accompanying minerals. The Troctolitic Series is present along the western margin of the southern part of the complex and intrudes the Anorthositic Series to the east; the latter series is genetically related to some Keweenawan flows. After the Anorthositic Series was emplaced, troctolite magma intruded along a widening fractured zone. Sulfide deposits in the southern Duluth Complex, with Cu-Ni potential, are syngenetic segregations in the lower Troctolitic Series. —ESL

04698 **Borg, I. Y.; Heard, H. C.** Mechanical twinning and slip in experimentally deformed plagioclases: Contr. Mineralogy and Petrology, v. 23, no. 2, p. 128-135, illus., table, 1969.

Mechanical albite and pericline twins were induced in seven feldspars, $(Na,Ca)(Al,Si)_4O_8$, in triaxial compression tests at 800°C and 8 to 10 kb confining pressure. Two were initially in high temperature structural state (disordered) (An_1, An_{59}). Three (An_{32}, An_{39}, and An_{53}) were slightly disordered, and two (An_{78} and An_{86}) had the transitional and primitive anorthite structure, respectively. No microscopic twinning was detected in comparable tests on ordered albite and oligoclase (An_1, An_{29}) feldspars in the peristerite range (An_{11}, An_{14}) or in a low structural state labradorite (An_{51}). Other deformational features include lamellae 60° or 80° from the *c* axis and (010) slip in the opposite sense for (010) twinning. —Authors' abstract

04731 **Botbol, J. M.** Characteristic analysis of base metal mining district mineralogy [abs.]: Mining Eng., v. 21, no. 8, p. 42, 1969.

04595 **Bothner, Michael; Johnson, Noye M.** Natural thermoluminescent dosimetry in late Pleistocene pelagic sediments: Jour. Geophys. Research, v. 74, no. 22, p. 5331-5338, illus., tables, 1969.

The natural thermoluminescence and associated radioactivities of four previously dated deep-sea cores have been examined for their compatibility as a radiation

dosimetry system. The radiation dose equivalence of the natural thermoluminescence in foraminiferal ooze is observed to build up systematically with increasing age. By 10^5 to 10^6 years, however, the dosimetry system in most calcareous ooze is effectively saturated. This pattern of dose build-up and saturation with time is consistent with certain general theoretical considerations. It appears, therefore, that the indigenous radiation dosimetry system of foraminiferal ooze, represented by its intrinsic thermoluminescence, is operating in a rational and predictable fashion and will provide reliable dosimetry data. —Authors' abstract

Boutté, A. L. *See* Moore, C. H., Jr. 04502

04527 **Boutté, Andre L.** Callahan Carbonate-Sand Complex, west-central Texas, *in* A guidebook to the depositional environments and depositional history, Lower Cretaceous shallow shelf carbonate sequence, west-central Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 40-74, illus., 1969.

Carbonate sands are a minor constituent of most of the Fredericksburg and equivalent rocks in west-central Texas. However, in a limited region just south and west of Abilene, lime grainstones make up to 60 percent of the total interval. This concentration is termed the Callahan Carbonate Sand Complex after exposures on the dissected northern edge of the Callahan divide. The following paper describes the distribution, sedimentary structure, lithologic facies, and depositional history of this deposit, and compares features where applicable to Recent counterparts. —*from* Author's introduction

04914 **Boyd, J. M.; Currie, J. B.** Fracture porosity in alabaster—An experimental model of rock deformation: Bull. Canadian Petroleum Geology, v. 17, no. 2, p. 117-132, illus., table, 1969.

Experimental deformation of alabaster furnishes useful observations concerning fracture development in a mineral aggregate. Study of deformed samples demonstrates that one or more types of fracturing can combine with kink-band development and other features to define the deformation mode that typifies a given range of confining pressure. Cluster analysis is used to delineate objectively the grouping of deformation features which constitutes the deformation mode. A comparison of experimentally determined values of differential stress at the linear elastic limit with computed values of the stress necessary to extend "Griffith" cracks suggests that microfracturing terminates purely elastic deformation at both low and high confining pressure. Detailed study of grain-boundary fractures indicates that in alabaster this particular type of deformation feature attains maximum development at relatively low levels of confining pressure and strain. —Authors' abstract

Braithwaite, L. F. *See* Hintze, L. F. 04432

04739 **Brawner, C. O.** Three big factors in stable slope design: Mining Eng., v. 21, no. 8, p. 73-77, illus., 1969.

Rock structure, ground-water conditions, and blasting techniques are important factors in stable slope design in open-pit mining. Rock structures affecting slope stability include jointing, bedding, and faulting; the interrelationships of the three are also important. Ground water affects slope stability by creating seepage pressures and buoyancy effects. Blasting affects slope stability by increasing shear stresses, creating new fractures and opening old ones to increase the danger of additional groundwater problems. Blasting can also liquify thixotropic materials such as fault gouge to the point of instability, and may create potential safety hazards by forming unstable piles of blasted rock. Practical examples of all three factors are given. —MAC

04814 **Bretz, J Harlen.** The Lake Missoula floods and the Channeled Scabland: Jour. Geology, v. 77, no. 5, p. 505-543, illus., tables, 1969.

This paper reviews evidence for repeated catastrophic floods of water, hundreds of feet deep in major channels and valleys, that resulted from recurrent outbursts from glacially-dammed Lake Missoula. Floodwaters overwhelmed several pre-existing

drainage divides on the Columbia Plateau in Washington, remade the Plateau drainage into an anastomosing complex of major channels (the Channeled Scabland), and eroded deep channels. Converging in the Columbia River valley, they formed great lakes upstream from valley constrictions, and deposited a large delta at Portland, Oregon. Among several unsolved problems is the number of floods, which occurred from possibly 100,000 years ago to some time before 12,000 years ago. —DRM

04977 **Bridgwater, D.; Gormsen, K.** Geological reconnaissance of the Precambrian rocks of south-east Greenland, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19. p. 43-50, illus., 1969.

A progress report on the 1968 field season is given. Included are discussions of new information from the central gneiss block, basic dike swarms, and the effects of the Nagssugtoquidian orogeny. —HRC

04761 **Briggs, P. C.** Ground-water conditions in McMullen Valley, Maricopa, Yuma and Yavapai Counties, Arizona: Arizona Land Dept. Water Resources Rept. 40, 31 p., illus., tables, 1969.

The ground-water reservoir is the only dependable source of water in McMullen Valley (western Arizona). Occurrence and use of ground water and geology of the area was reported by Kam (1964); basic data presented here have been acquired since that time. Withdrawals have caused water-level declines, changes in flow pattern, and decrease in amount of ground water in storage. In general the ground water is well suited for irrigation because of low dissolved-solids content, but its fluoride content is from two to ten times the maximum recommended for drinking water. Basic data include records and drillers' logs of selected wells, and chemical analyses and field determinations of temperature and specific conductance of water from selected wells. —MCM

04970 **Briggs, P. C.** Ground-water conditions in the Ranegras Plain, Yuma County, Arizona: Arizona Land Dept. Water-Resources Rept. 41, 28 p., illus., tables, 1969.

In the Ranegras Plain nearly all cultivated acreage and ground water pumped are within an area of about 200 sq mi north of U.S. Highway 60-70 and south of Bouse. The first large irrigation wells were drilled in 1948; by spring 1949 about 1,000 acres was being irrigated, by 1957 land being irrigated had increased to 5,000 acres, but by 1967 only 2,800 acres was under irrigation. From 1948 through 1967 about 211,000 acre-feet of ground water was pumped. Changes in water level have been minor to 1967. Water levels have declined more than 15 feet in only a small part of the area; declines of from 10-15 feet have occurred in a fairly large area. The ground water contains varying amounts of dissolved minerals and is permissible to unsuitable for irrigation. —*from* Author's summary

04404 **Bristol, C. C.; Bristol, N. A.** The determination of the low temperature plagioclase feldspars by peak height measurement [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 127, 1969.

Bristol, N. A. *See* Bristol, C. C. 04404

04799 **British Columbia University.** (Dept. Geology). Abstracts of published papers, theses, and oral presentations of the students and faculty, Department of Geology, during 1968: British Columbia Univ. Dept. Geology Rept. 9, 50 p. [1969,].

04800 **British Columbia University.** (Dept. Geology). Abstracts of published papers, theses, and oral presentations of the students and faculty, Department of Geology, January 1, 1969 to June 30, 1969: British Columbia Univ. Dept. Geology Rept. 10, 33 p. [1969,].

Brobst, D. A. *See* Shawe, D. R. 04550

04340 **Brooks, C.; Hart, S. R.; Krogh, T. E.; Davis, G. L.** The initial Sr^{87}/Sr^{86} of Michipicoten greenstones and its bearing on the development of the mantle [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 127-128, 1969.

04341 **Brooks, C.; Hart, S. R.** On the realistic use of Rb-Sr isochron regression treatments [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 127, 1969.

04976 **Brooks, C. K.; Bohse, H.** New field investigations of the Illímaussaq kakortokite, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 41-42, 1969.

About 28 units, each consisting of a black, red, and white layer were recognized and sampled. Two distinctive red horizons were recognized for mapping datums; both are thick and very rich in eudialite. Another distinctive layer is crushed kakortokite which was apparently formed by shearing along the plane between two units shortly after consolidation. The augite-syenite inclusions are confined to one layer, at sea level in one place and 900 feet above in another. The exact relation between the kakortokite and the lujavrites is uncertain but there may be a lateral transitional relation between the two. —HRC

04559 **Brooks, Elwood R.; Garbutt, Phillip L.** Age and genesis of quartz porphyry near White Pine, Michigan: Econ. Geology, v. 64, no. 3, p. 342-346, illus., 1969.

A large body of quartz porphyry 5-8 miles south of White Pine is extrusive, and its contact with the overlying rocks is at least a local unconformity. It lies stratigraphically far below the Nonesuch Shale, and therefore cannot be a source for the solutions that introduced the copper. The Rb/Sr age reported by Chaudhuri and Faure (1967) for the quartz porphyry is younger than the age reported for rocks higher in the section, and one or the other age is therefore anomalous. —WSW

04599 **Brotchie, J. F.; Silvester, R.** On crustal flexure: Jour. Geophys. Research, v. 74, no. 22, p. 5240-5252, illus., tables, 1969.

The deformation of the Earth's crust under superposed loads is considered as a problem in structural mechanics. The crust is treated as a uniform, elastic, thin, spherical shell, and the mantle is treated as an enclosed viscous liquid. Equations relating loading and crustal response are developed. Loadings may be spatially concentrated, locally distributed, or global and may be applied as a steady-state or transient condition. Crustal displacements under reservoir loadings, glacial sheets, and sea-level rises are predicted and agree well with observations both in magnitude and in time. The Wisconsin glaciation in North America is treated in particular. —Authors' abstract

04609 **Brown, Alexander Cyril.** Zoning in the White Pine copper deposit, Ontonagon County, Michigan [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 253B, 1969.

04501 **Brown, Jerry.** Soils of the Okpilak River region, Alaska [with French abs.], *in* The periglacial environment, past and present (T. L. Péwé, editor)—Internat. Assoc. Quaternary Research, 7th Cong., Alaska, 1965: Montreal, Quebec, McGill-Queen's Univ. Press, p. 93-128, illus., tables, 1969.

Frost action shows in (1) surficial configurations or patterned ground and in (2) the morphologic characteristics of the seasonably thawed soil and the upper zone of the perennially frozen ground. About 55 types of soil conditions and surface features occur in the Brooks Range and the northern foothills. Arctic brown soils are distributed on the well-drained sites along valley traverses and across mountain gradients. In valley moraines, acid parent material is more important than time or microenvironment. Weakening of the soil-forming processes with increasing altitude occurs also. In valleys, a podzol-like soil occurs close to the brown soils and in association with acid parent materials, dwarf birch-heath vegetation, and protected microrelief positions. A peaty soil associated with ice wedge polygons constitutes an organic terrain. —*from* Author's abstract

04479 **Brown, L. F., Jr.** Virgil and lower Wolfcamp repetitive environments and the depositional model, north-central Texas, *in* Cyclic sedimentation in the Permian Basin—Symposium, Midland, Tex., 1967: West Texas Geol. Soc. Pub. 69-56, p. 115-134, illus., 1969; *reprinted as* Texas Univ. Bur. Econ. Geology Geol. Circ. 69-3, 1969.

Virgil and lower Wolfcamp rocks on the Eastern Shelf in north-central Texas are composed of several intergradational depositional systems comprising 1,200 to 1,500 feet of off-lapping, predominantly terrigenous sediments. At least 12 major and numerous minor repetitive sequences consist of superposed depositional systems. Facies tracts shifted southwestward during Virgil and Wolfcamp deposition as the average strandline migrated with westward shelf progradation. The fluvial-deltaic model for Virgil and lower Wolfcamp rocks makes it unnecessary to invoke external cyclic control to explain the north-central Texas deposits. —*from* Author's abstract

04520 **Brown, L. F., Jr.** Late Pennsylvanian paralic sediments, *in* A guidebook to the Late Pennsylvanian shelf sediments, north-central Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 21-33, illus., 1969.

Rocks of Virgil and lower Wolfcamp age, the Cisco Group, are discussed. The distribution of sandstone bodies within predominantly mudstone bodies provides data on the paleoslope; the distribution of mudstone, limestone, and sandstone facies is presented in detail. Fluvial, deltaic, open shelf and interdelta systems are recognized. The rocks are the result of rapidly shifting fluvial and deltaic environments, and repetitive units or cycles(,) can be identified. The persistence of widespread limestone units permits recognition of mudstone-sandstone formats between them. At the time of the shifting fluvial-deltaic deposition the shelf was also subsiding and marine destruction occurred, as did mud compaction-subsidence; this was followed by open-shelf marine transgression. —HRC

04523 **Brown, L. F., Jr.; Galloway, W. E.; Kessler, L. G., 2d.** Field trip, second day, *in* A guidebook to the Late Pennsylvanian shelf sediments, north-central Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 52-68, illus., 1969.

The second day of the trip begins in Graham and ends near Cisco. Four stops are made to examine several of the component facies within postulated delta, fluvial, and interdelta depositional systems of Upper Pennsylvanian age in the Brazos valley. The stops include a marine-basal delta transition zone, interdistributary deposits in a post-Ivan subdelta complex, interdeltaic facies, and a channel-fill facies. Each stop is extensively described, but no mileage or geologic observations enroute are included. —HRC

Brown, L. Frank, Jr. *See* Dallas Geological Society. 04539

04500 **Brown, R. J. E.** Factors influencing discontinuous permafrost in Canada [with French abs.], *in* The periglacial environment, past and present (T. L. Péwé, editor) —Internat. Assoc. Quaternary Research, 7th Cong., Alaska, 1965: Montreal, Quebec, McGill-Queen's Univ. Press, p. 11-53, illus., table, 1969.

East of Hudson Bay permafrost extends from the Laurentide scarp north to 58°N., and between the bay and the cordillera it extends northwesterly in a broad band several hundred miles wide to the northern portions of the provinces and the southern portions of the territories. Climatic control of this discontinuous permafrost is borne out by its relation to the mean annual temperature. Permafrost is virtually continuous north of the 20°F mean air isotherm. The distribution of individual islands of permafrost is conditioned by variations in microclimate and terrain features such a relief, drainage, vegetation, and snow cover. The permafrost in Canada's discontinuous zone probably formed after the final retreat of the ice sheets or postglacial inundations, except in the unglaciated portions of the Yukon Territory where its formation is periglacial. —*from* Author's abstract

04825 **Bryson, Reid A.; Wendland, Wayne M.; Ives, Jack D.; Andrews, John T.** Radiocarbon isochrones on the disintegration of the Laurentide ice sheet: Arctic and Alpine Research, v. 1, no. 1, p. 1-13, illus., 1969.

Ice sheet disintegration occurred between 13,000 and 5,000 years ago. Two maps show isolines drawn on radiocarbon data, the only assumption being that the ice sheet perimeter tended to parallel the trend of the outer edge of the continental shelves and the southern limit of Wisconsin till on land; the second map is a subjective interpretation of the first, based on field evidence. The northern limit was close to the Arctic mainland coast of Canada. There was a change from an E-W ice barrier near 60° N. in Late Glacial time to a broad low corridor from the Arctic to the Great Plains in Boreal time. The ice sheet was distinct until about 8400 B.P., and the remnants persisted over Keewatin, Labrador-Ungava, and Foxe basin-Baffin Island through the Atlantic climatic episode, and remain to this day on Baffin Island as the Barnes Ice Cap. —HRC

04557 **Bubenicek, L. A.** The formation of sedimentary iron minerals [discussion of paper by C. D. Curtis and D. A. Spears, 1968]: Econ. Geology, v. 64, no. 3, p. 341, 1969.

Attention is called to the genetic model developed for the Lorraine, France, sedimentary iron orebody but essentially applicable to any sedimentary ore deposit. The model partly contradicts the conclusions of Curtis and Spears (ibid., v. 63, no. 3, p. 257-270, 1968); however, a literature review indicates that no genetic theory for oolitic ores has led to a workable model. —VSN

Buck, Cleo E. *See* Thompson, Fred M., Jr. 04916

04919 **Buck, Cleo E.** Charles I. Jennings (1894-1968): Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 2012-2013, portrait, 1969.

04863 **Buckley, Jane T.** Gradients of past and present outlet glaciers: Canada Geol. Survey Paper 69-29, 13 p., illus., tables, 1969.

Gradients have been calculated for a large number of outlet glaciers entering fiords in Alaska, Greenland, Antarctica, and Arctic Canada. A linear relationship exists between the overall length and the gradient of these glaciers. This method finds application in the reconstruction of ice surfaces of former outlet glaciers in areas previously glaciated, and an example is taken from Baffin Island. —Author's abstract

04994 **Bullard, Edward.** The origin of the oceans: Sci. American, v. 221, no. 3, p. 66-75, illus., 1969.

Data gathered largely in the last ten years from many sources about ocean basins and continents are synthesized lucidly into an outline of the plate theory of sea-floor spreading and continental drift. The present oceans are relatively young, containing no sediments older than 150 million years and very older than 80 million years. The floor of the deep ocean is growing outward from midocean ridges, pushing most of the continents apart as it does. —DWR

04755 **Bullivant, J. S.** The Bathhouse Beach assemblage: Southern California Acad. Sci. Bull., v. 68, pt. 2, p. 86-95, 1969.

The Lower Pleistocene, Bathhouse Beach locality, Santa Barbara, Calif., was examined. The described fauna of molluscs, bryozoans, foraminiferans, ostracods and brachiopods was reviewed and latitude range and depth distributions noted. The bulk of the fauna with perhaps the exception of the foraminiferans occurs off the coast of California today and the affinity of the fauna is decidedly with the Recent Californian rather than with the Aleutian or Panamic provinces. The cyclostome bryozoan *Diaperoecia californica* was so abundant in the deposit as to give it the character of a biostrome. The bulk of the sediment in the deposit was carbonate, the remainder silt. The biostrome was in a region of slow sedimentation, away from the shoreline. Its top in 36.6-54.9 m was capped by coralline algae which provided a substrate for the bryozoan. —Author's abstract

Bunch, T. *See* Olsen, E. 04379

Bur, T. R. *See* Thill, R. E. 04443

04788 **Burk, C. F., Jr.** The national system for storage and retrieval of geological data in Canada: Geoscience Inf. Soc. Proc., v. 1, p. 1-7, illus., 1969.

A computer-based system for storage and retrieval of geological information is being developed in Canada; it is designed for independent use by any organization and for maximum interface between all files. Uniformity is sought in methods of indexing. Pilot tests have been made. The system will be monitored by a Secretariat consisting of a National Coordinator and a clerical staff. —Author's abstract

Burnham, C. W. *See* Veblen, D. R. 04356

04495 **Byerlee, James D.** Reply [to comments by K. J. Hsu, 1969, on "Frictional characteristics of granite under high confining pressure", 1967]: Jour. Geophys. Research, v. 74, no. 22, p. 5349-5350, illus., 1969.

In Hsu's comments (ibid., v. 74, no. 6, p. 1712-1713, 1969) on Byerlee's paper (ibid., v. 72, no. 14, p. 3639-3648, 1967) some confusion has arisen as to the meaning of the constant terms in the Coulomb or Coulomb-Navier criterion of rock fracture, and in addition Hsu has mistakenly assumed that the Coulomb theory is the same as the Mohr theory of failure. This reply attempts to correct the misunderstanding. —DBV

Cabri, L. J. *See* Petruk, W. 04384

Cabri, L. J. *See* Harris, D. C. 04392

04405 **Cabri, L. J.; Harris, D. C.** New minerals from an unusual antimonial assemblage from the Red Lake area, Ontario [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 128, 1969.

04769 **Cagle, J. W.** Availability of ground water in Wayne County, Iowa: Iowa Geol. Survey Water Atlas 3, 33 p., illus., tables, 1969.

Data indicate that only locally and in limited areas, or only after extensive water-quality treatment, are suitable supplies of ground water available to satisfy needs in Wayne County. Bedrock aquifers yield variable amounts of moderately to highly mineralized water: upper units at depths of 200-1,000 feet, up to 50 gpm of water with dissolved-solids content from 2,000-5,500 mg/l; lower units at depths of 2,500-2,800 feet, probably capable of 300-800 gpm with dissolved-solids content from 800-2,500 mg/l. Surficial aquifers of glacial drift and alluvium are estimated to yield up to 45 gpm in some areas; chemical quality varies considerably. Many shallow supplies presently in use contain high concentrations of nitrate and chloride, but properly constructed and located wells are expected to yield satisfactory quality water. —*from* Author's abstract

04859 **Caley, J. F.; Liberty, B. A.** Geology, Lake Simcoe area, Ontario: Canada Geol. Survey Map 1228A (also in Mem. 355), scale 1:253,440, 1969.

Cameron, A. E. *See* Wampler, J. M. 04870

Camfield, P. A. *See* Caner, B. 04686

Campbell, R. B. *See* Hughes, O. L. 04973

04880 **Canada Geological Survey.** Aeromagnetic series, Lac Évans, Quebec: Canada Geol. Survey Geophysics Paper 7364, scale 1:253,440, 1969.

04881 **Canada Geological Survey.** Aeromagnetic series, Sheet 12 P/15, Newfoundland: Canada Geol. Survey Geophysics Paper 5549, scale 1:63,360, 1969.

04882 **Canada Geological Survey.** Aeromagnetic series, Barge Bay, Newfoundland: Canada Geol. Survey Geophysics Paper 5550, scale 1:63,360, 1969.

04883 **Canada Geological Survey.** Aeromagnetic series, Rivière Harricana Inferiéure, Quebec: Canada Geol. Survey Geophysics Paper 7116, scale 1:253,440, 1969.

04884 **Canada Geological Survey.** Aeromagnetic series, Lac Assinica, Quebec: Canada Geol. Survey Geophysics Paper 7363, scale 1:253,440, 1969.

04343 **Cane, P.** Nucleation of biotite in a cooling tinguaite dyke [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 128, 1969.

04686 **Caner, B.; Camfield, P. A.; Andersen, F.; Niblett, E. R.** A large-scale magnetotelluric survey in western Canada: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1245-1261, illus., 1969.

Five magnetotelluric stations were operated in two clusters in southern British Columbia and Alberta, in order to determine the conductivity structures in each of the two main regions delineated by geomagnetic depth-sounding. A wide period range was covered (20 to 7500 seconds), to permit resolution of structure at lower crustal and upper mantle depths. At the eastern cluster (Pincher, Fernie), a moderately conducting zone (30-50 ohm-meters) is defined starting at depth 30-35 km and extending to a depth of at least 100 km. At the western cluster (Penticton, Osoyoos, Grand Forks) a conducting layer (10 ± 5 ohm-meters) starts at depth 15 ± 5 km; below this layer (of thickness 20-40 km) the resistivity increases to a value of the same order (30-50 ohm-meters) as at the eastern cluster. —Authors' abstract

04936 **Cannon, Ralph S., Jr.; Pierce, Arthur P.** Lead isotope guides for Mississippi Valley lead-zinc exploration: U.S. Geol. Survey Bull. 1312-G, p. G1-G20, illus., 1969.

Lead in stratiform lead-zinc deposits in many world regions varies notably in isotopic composition; these variations are potential guideposts for exploration geologists searching for major lead deposits of this class. In the Mississippi Valley, stratiform lead-zinc deposits contain so-called J-lead, relatively enriched in radiogenic Pb-206, Pb-207, and Pb-208. For each of the four most important producing districts, a favorable range of lead isotope composition is defined, within which one may concentrate search for major deposits; in two districts geographic areas where lead of favorable compositions can be found are delineated, and within a third, more intensive investigations have detected 3-dimensional gradients of isotope variation in individual mineralized areas. Lead isotope data from these four districts define compositions of lead most likely to lead to new major discoveries. —*from* Authors' abstract

Cantwell, Thomas. *See* Vozoff, Keeva. 04903

04344 **Carmichael, D. M.** The replacement of carbonate porphyroblasts during prograde metamorphism in the Whetstone Lake area, Ontario [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 128-129, 1969.

04738 **Carmichael, Virgil W.** Simple air-photo techniques pare exploration and mining costs: Mining Eng., v. 21, no. 8, p. 69-72, illus., 1969.

Large areas of the Paleocene Fort Union Formation in North Dakota, Wyoming and Montana, contain potential lignite and subbituminous coal reserves. These reserves, which occur in nearly flat-lying discontinuous lenses, were mapped and evaluated economically using inexpensive air-photo techniques. Preliminary planimetric and geologic maps made from the air photos were field checked at the same time that topographic control was added. Limited drilling was then done to clarify the third dimension. The above procedures, which are described in detail, were used to plan reclamation; calculate reserves; locate drains, roads, and road metal deposits; and for property studies and general planning. —MAC

04579 **Carroll, Robert L.** Problems of the origin of reptiles: Cambridge Philos. Soc. Biol. Rev., v. 44, no. 3, p. 393-432, illus., 1969.

The four orders of living reptiles can be traced back to the Triassic; excepting the turtles, they evolved from Late Permian eosuchians and thecodonts, both of which are traced back to the captorhinomorphs, which were already fully developed reptiles in the Lower Pennsylvanian. Limnoscelids and solenodonsaurids were more primitive, retaining some features of anthracosaurian amphibians. Although true ancestors of

reptiles are not known, the Middle Pennsylvanian anthracosaur *Gephyrostegus* resembles the expected reptilian ancestors more than do the Permian seymouriamorphs; all adequately known Paleozoic reptiles, except diadectids, also can be traced to gephyrostegid predecessors. Gephyrostegids should be excluded from Seymouriamorpha and placed in a taxon of equal rank. Morphological changes during the amphibian-reptilian transition are interpreted from available evidence. —VMJ

04956 **Carter, W. D.** Air- and space-borne remote sensors for mineral exploration, *in* Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, p. 109-111, 1969.

This is primarily a description of and an exhortation for the EROS satellite program. The four types of studies are: empirical investigations (photography), instrument investigation (various remote-sensing devices), theoretical investigations (physical and chemical laws fundamental to a knowledge of remote sensors), and benefits investigations (to determine the relative merits and cutoff points). Some results are already known from the high-level photography from the Gemini flights wherein low sun-angle photographs have revealed geology heretofore unsuspected. Soil mapping is also underway as a product of color photography from high altitudes. —HRC

04742 **Cartwright, Keros; Sherman, Frank B.** Evaluating sanitary landfill sites in Illinois: Illinois Geol. Survey Environmental Geology Note 27, 15 p., illus., 1969.

Locations where disposal can take place above the water table in Illinois are relatively rare; principal aquifers are in unconsolidated sand and gravel deposits of glacial drift and river valleys, and sandstone and limestone formations within the bedrock. Strip mines and clay and gravel pits are acceptable disposal sites if kept dry, and flat upland areas have possibilities if the required natural clay barrier is present above any aquifer. Careful selection of a landfill site will result in a minimum of operating problems and little danger of water pollution. Outlined investigative procedures are those currently followed by the Illinois State Geological Survey for reconnaissance evaluation of landfill sites; maps indicate areas where probability of locating favorable sites is good, bad, and intermediate. —MCM

04616 **Case, D. R.; Laul, J. C.; Wechter, M. A.; Schmidt-Bleek, F.; Lipschutz, M. E.** Simultaneous measurement of seventeen trace elements in eight geochemical standards —A novel adaptation of neutron activation analysis, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 409-412, 1969.

A novel adaptation of neutron activation which utilizes high-resolution gamma-ray detectors, a re-irradiation technique for chemical yield determination, and computer analysis for data reduction is described. The method was designed particularly for simultaneous analysis of numerous elements in meteorites, and was tested by analysis of eight USGS geochemical standards; results are not given but are stated to be in good agreement with those obtained by other methods. —VSN

04950 **Caudle, W. N.; Pope, A. Y.; McNeill, R. L.; Margason, B. E.** Terradynamics—The feasibility of rapid soil investigations using high-speed, earth-penetrating projectiles, *in* Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, p. 45-59, illus., 1969.

Projectiles dropped from helicopters or airplanes record the physical and dynamic properties of the material into which they penetrate, and these records can then be used to determine the nature of the materials. Two limitations have been identified: (1) the data are dynamic, and (2) the engineer does not see or feel the earth materials, so that while useful for feasibility studies, the records cannot be used for final designs. The strong points of the system are: (1) material types, strong and weak materials, and layers and surfaces can be identified, (2) dynamic data are applicable to static design tests, and (3) preliminary studies show the system has good correlation with the standard penetration blow count. The method is especially useful in areas which are not easily accessible. —HRC

04860 **Chamney, T. P.** Barremian Textulariina, Foraminiferida from Lower Cretaceous beds, Mount Goodenough section, Aklavik Range, District of Mackenzie [with French abs.]: Canada Geol. Survey Bull. 185, 41 p., illus., table, 1969.

A Lower Cretaceous upper shale-siltstone division (Jeletzky, 1958) outcrops on the east flank of Mount Goodenough, west of Mackenzie River Delta. The basal beds contain abundant agglutinated forms of Foraminiferida [of suborder Textulariina]. This microfauna comprises 14 genera, 28 determined species and one subspecies, and 8 indefinite species taxa. Fourteen species and one subspecies are new. Some elements of the microfauna compare with the zone *Verneuilinoides sublithiformis* of Bartenstein (1954) from northwestern Germany, which is of Barremian (Upper Neocomian) age. —Author's abstract

04556 **Chandra, D.** Refractive indices of coals carbonized under pressure: Econ. Geology, v. 64, no. 3, p. 338-340, illus., 1969.

Coals were carbonized at pressures up to 6000 atmospheres, at temperatures of 325°C and 350°C, and for periods up to 25 days. Refractive index and carbon contents tend to lie between the curve obtained by plotting refractive index against carbon content for natural regionally metamorphosed coals and the curve for coals carbonized without excess pressure. —WSW

Chao, G. Y. *See* Hounslow, A. W. 04388

Chao, G. Y. *See* Moore, J. M., Jr. 04408

04552 **Chao, T. T.** Determination of gold in waters in the nanogram range by anion exchange and atomic absorption spectrophotometry: Econ. Geology, v. 64, no. 3, p. 287-290, illus., table, 1969.

A method has been developed whereby nanogram amounts of gold in waters can be accurately determined. The development of the method involves determination of optimum conditions for the complete recovery of gold from water using an anion exchange resin column, quantitative elution of gold from the resin, and final measurement of gold by atomic absorption spectrophotometry following methyl-isobutyl-ketone extraction of gold from a nitric-acid solution. —Author's abstract

04410 **Charlier, Roger H.** The geographic distribution of Polar Desert soils in the northern hemisphere: Geol. Soc. America Bull., v. 80, no. 10, p. 1985-1996, illus., 1969.

The soil of Arctic areas is generally said to be Tundra. Recent research indicates that the zonal diagram depicting a Podzol-Tundra-firn sequence northward from the fringes of the northern forest does not realistically reflect physical conditions in the northern extremities of ice-free land. These extremities are primarily mantled with Polar Desert soils which are at times only sparsely colonized by vascular plants that are typical of regions of low temperatures, rather dry soil conditions, and mildly acid to alkaline in reaction with salt efflorescences. A substantial effort should be made by scientists to unify soil nomenclature in the Arctic or at least to establish equivalent terminology. Fundamental studies on Arctic soil are long overdue with cartography not one of the least important. —*from* Author's abstract

Charmatz, Richard. *See* Ellis, Brooks F. 04582

04768 **Chayes, F.** A least squares approximation for estimating the amounts of petrographic partition products [with Italian abs.]: Mineralog. et Petrog. Acta 1968, v. 14, p. 111-114, table, 1969.

Petrological 'subtraction' or 'mixing' problems may be treated by least squares methods. The Skaergaard Complex in Greenland is used as an illustration of the method and of insights provided. A table gives compositions of average layered rocks at midpoints of certain zones, and of presumed parent magma. The sum of the negative coefficients reaches an impasse reflecting inadequacy of the fractionation hypothesis, unfortunate choice of parent magmas, or incorrect estimates of compositions of the zones. Without this check, it has been presumed for 30 years that the

zone compositions and 'parent magma' formed a set at least numerically consistent with the hypothesis that the former are partition products of the latter. —ESL

04367 **Chesworth, W.** Origin of the older granitoid rocks of Glamorgan Township, Ontario [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 129, 1969.

Christ, C. L. *See* Erd, Richard C. 04407

04600 **Christensen, M. N.; Gilbert, C. M.; Lajoie, K. R.; Al-Rawi, Yehya.** Geological-geophysical interpretation of Mono basin, California-Nevada: Jour. Geophys. Research, v. 74, no. 22, p. 5221-5239, illus., tables, 1969.

The geology of the margins of the Mono basin, California, suggests that the basin is a relatively shallow warp. When interpreted in the light of detailed study of the basin fill and of the geologic history of the region, the gravity and seismic data are consistent with the basin's being filled to a depth of 1 to 1.5 km, largely with sedimentary deposits. The geophysical data have been interpreted by others to indicate that the basin subsided deeply along nearly vertical faults and is filled to a depth of approximately 5 km with Cenozoic deposits, including a large volume of volcanic material. The basin appears to be the product of a regional pattern of warping and faulting and is not to be regarded as a volcano-tectonic depression, as has been suggested. —Authors' abstract

Christian, R. P. *See* Mrose, M. E. 04377

04967 **Christie, K. W.; Symons, D. T. A.** Apparatus for measuring magnetic susceptibility and its anisotropy: Canada Geol Survey Paper 69-41, 10 p., illus., 1969.

The apparatus, built to determine rapidly magnetic susceptibility and/or its anisotropy in rock specimens in a low a.c. field, accepts cubic or right cylindrical specimens up to 22 cc in volume. Two balanced a.c. transformers are coupled to a low-noise high-gain amplifier and digital voltmeter allowing volume susceptibilities as low as 5×10^{-6} emu to be measured. To measure susceptibility only (15 sec), the specimen is placed in the center of one of two identical sets of coaxial transformer coils with amount of unbalance created being linearly related to susceptibility. The latter may be measured by placing the specimen in the ferrite core's air gap in one of two identical incomplete-toroid transformers; susceptibility anisotropy is measured (2 min) by moving a ferrite slug into the other air gap to balance the specimen's axial susceptibility and rotating the specimen to measure susceptibility difference for its other axes. —*from* Authors' abstract

Chuber, Stewart. *See* Elam, Jack G. 04348

04481 **Chuber, Stewart; Pusey, Walter C.** Cyclic San Andres facies and their relationship to diagenesis, porosity and permeability in the Reeves field, Yoakum County, Texas, *in* Cyclic sedimentation in the Permian Basin—Symposium, Midland, Tex., 1967: West Texas Geol. Soc. Pub. 69-56, p. 136-151, illus., 1969.

The Reeves Field, Yoakum County, Texas, contains the record of a shelf edge. Depositional cycles begin with an initial low-energy phase representing relatively deep water. On the seaward and crestal parts of the field area, oolitic grainstones predominated; on the back shelf area stromatolitic mudstones predominated. This depositional pattern coupled with a high rate of evaporation established a reflux system which led to the precipitation of gypsum and carbonates. Porosity and permeability were developed in the dolomitized mudstones. After lithification, the weight of overburden produced a fracture system, which may have provided access routes for oil migration. —KAF

04697 **Chun, D.; Schlater, J. E.; Kachik, V. J.** The ARL surface fitting-contouring program, *in* Operations research and computer applications in the mineral industries: Colorado School Mines Quart., v. 64, no. 3, p. 379-393, illus., tables, 1969.

This paper describes the algorithm used in a surface fitting-contouring program as developed at the Applied Research Laboratory. The program makes use of an orthogonal transformation on the polynomial model before performing the regression analysis. The transformation, therefore, avoids the need to invert a highly ill-conditioned matrix and should improve the reliability of the results. —*from* Authors' abstract

04639 **Cinnamon, Charles Gerald.** Parameters and structural variations of the intermediate composition, low plagioclases [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 253B-254B, 1969.

04891 **Clague, John J.** Landslides of southern Point Reyes National Seashore: California Div. Mines and Geology Mineral Inf. Service, v. 22, no. 7, p. 107-110, 116-118, illus., 1969.

Some of the largest ancient landslides in the San Francisco Bay area are on a four-mile stretch on the coastal side of Inverness Ridge at the south end of Point Reyes. Most of the area is now stable, but the lakes owe their existence to these slides. The landslide area is in a region of moderately rugged topography; a coastal terrace, a raised wave-cut bench, represents a sea level about 200 feet above present. Rocks involved in the landslides are of Miocene-Pliocene age and belong in part to the Monterey Formation and in part to Pliocene rocks in the Coast Ranges. The Wildcat slide can be divided into four units, each having moved at a different time. The Double Point slide includes three large blocks that may have moved independently. Causes of the slides, still taking place, include Tertiary soft shale and sandstone, the steep coast, water buoying up the landslide mass, and proximity to the San Andreas fault. —ESL

Clark, D. L. *See* Hintze, L. F. 04432

04789 **Clarke, James W.** Automatic data processing of geological literature by the United States Geological Survey: Geoscience Inf. Soc. Proc., v. 1, p. 8-12, 1969.

Since its beginning in 1884 the information system of the United States Geological Survey has developed continuously to meet the ever changing nature of geologic research. Geophysical Abstracts and Abstracts of North American Geology are now published monthly, and the preparation of these journals beyond the "rough-draft" stage is completely automated. Magnetic tapes prepared during this process are used to compile yearly indexes, and these yearly tapes then become archival tapes for automatic retrieval of bibliographic data. The search program for the bibliographic data should be coordinated where possible with other information storage and retrieval systems in geology. —Author's abstract

Clayton, Robert N. *See* Tarutani, Toshikazu. 04544

Clayton, Robert N. *See* Robinson, Michael. 04545

Clements, Thomas. *See* Leakey, Louis S. B. 04459

Coch, Nicholas K. *See* Bick, Kenneth F. 04899

04446 **Coe, Robert S.; Paterson, Mervyn S.** The α-β inversion in quartz—A coherent phase transition under nonhydrostatic stress: Jour. Geophys. Research, v. 74, no. 20, p. 4921-4948, illus., tables, 1969.

Experiments on oriented cores from a single crystal of quartz show that the temperature of the α-β transition is raised 10.6 ± 0.4°C per kb and 5.0 ± 0.4°C per kb by uniaxial compression perpendicular and parallel, respectively, to the optic axis at a confining pressure of 3 kb. Approximately the same results are indicated for confining pressures ranging from 1 to 5 kb. These results and others for quartz are analyzed assuming the α-β inversion is either a A transition or a first-order transition characterized by a small reversible transformation strain. Although both hypotheses are roughly consistent with most of the results, the hysteresis in the transition suggests

that the second may be preferable, and a theory is developed that describes the effect of general nonhydrostatic stress on such transitions. —*from* Authors' abstract

04727 **Collette, B. J.; Ewing, J. I.; Lagaay, R. A.; Truchan, M.** Sediment distribution in the oceans—The Atlantic between 10° and 19° N.: Marine Geology, v. 7, no. 4, p. 279-345, illus., 1969.

Continuous seismic reflection recordings, along four E-W crossings of the North Atlantic between 10° and 19° N. and one N-S section at 60° W., indicate few or no sediments over the Mid-Atlantic Ridge and thicknesses of the order of 1 km in fracture zones offsetting the ridge, 2,000 m in the Cape Verde-Madeira Abyssal Plain, and of >1,400 m in Demerara Abyssal Plain. Evidence exists for current-influenced sedimentation other than turbidity, for erosion at depths of more than 5,000 m, and for turbidite deposition on slopes of inclination of 12'. Horizon A at 700 km from the Mid-Atlantic Ridge axis gives a maximum of 1.2 cm per yr possible spreading since Upper Cretaceous. Distribution of sediments on the Ridge and configuration of basins to both sides, suggest that both the negative gravity zones and ridge are secondary and relatively young with regard to continental drift and ocean spreading. —VSN

04345 **Colman-Sadd, S. P.** Iron oxide deposits of the Indian Head Range in western Newfoundland [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 129-130, 1969.

04696 **Connor, J. J.** A geochemical discriminant for sandstones of Mississippian and Pennsylvanian age in Kentucky, *in* Operations research and computer applications in the mineral industries: Colorado School Mines Quart., v. 64, no. 3, p. 17-34, illus., table, 1969.

Two-group discriminant function analysis of geochemical data from Mississippian and Pennsylvanian sandstones in Kentucky indicates that sufficient differences in chemical content exist between outcrops of the two kinds of sandstone to serve as an aid in distinguishing between them. The discriminant function $Z = -4.14 \text{ Log } Al_2O_3 + 3.83 \text{ Log MgO} - 5.03 \text{ Log } TiO_2 - 9.89 (\text{Log } H_2O^+)^2 - 0.803(\text{Log Cr})^2$, based on percent concentration of chemical constituents, has a test value of $Z_T = -8.50$. Three of four sandstone samples taken from an isolated outcrop of uncertain age were classified by this function as Mississippian in age. —*from* Author's abstract

04805 **Conway, Clay M.; Taylor, Hugh P., Jr.** O^{18}/O^{16} and C^{13}/C^{12} ratios of coexisting minerals in the Oka and Magnet Cove carbonatite bodies: Jour. Geology, v. 77, no. 5, p. 618-626, illus., tables, 1969.

Oxygen isotope analyses were obtained for five magnetites, three biotites, two melilites, one apatite, one niocalite, and one pyrochlore from five samples of okaite and carbonatite in the Oka, Quebec, and Magnet Cove, Ark., complexes. Calcites from these and three other samples were analyzed for both O-18/O-16 and C-13/C-12. The order of increasing O-18 concentration among minerals is consistent in all samples. Calculated whole-rock δ O-18 values are similar to those of mafic and ultramafic igneous rocks, and the δ O-18 and δ C-13 values of the calcites fall within the range previously suggested for primary igneous carbonatites. Crystallization temperatures, calculated from O-18 fractionations for the pair calcite-magnetite, demonstrate that the okaites and carbonatites crystallized at about the same temperature as, respectively, gabbros and "granitic" igneous rocks. —*from* Authors' abstract

04349 **Coogan, Alan H.** Recent and ancient carbonate cyclic sequences, *in* Cyclic sedimentation in the Permian Basin—Symposium, Midland, Tex., 1967: West Texas Geol. Soc. Pub. 69-56, p. 5-16, illus., 1969.

The depositional cycle as a simple model for interpreting the stratigraphic record is limited because of insufficient documentation, peculiarities of the Recent transgression, the effect of evolution, and the combined effects of topography and physical and biological forces on sedimentation. The facies model serves better as a base for explaining sedimentary patterns, but it does not account for rock sequences. A more complete approach to evaluating rock sequences is to combine the facies model and

the recurrent cycles of transgression and regression. The irregularity and randomness of sequential events resulting from the interplay of physical and biological forces on an inherited topographic base seem to negate the strictly cyclic nature of sedimentation and to reduce the usefulness of the cyclic model. —*from* Author's abstract

04948 **Cook, Douglas R.** The effective use of exploration technique, *in* Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, p. 25-32, illus., 1969.

The estimated cost per discovery per economic mineral deposit in the United States is over 20 million dollars. More thorough exploration planning and a concept-oriented program may help reduce costs. Techniques should be selected on the basis of their discriminatory capability. Pitfalls in exploration include problems in data collecting and their measurement, problems of interpretation, and the use of techniques. The need for the use of the multiple working hypothesis is also stressed, to improve the quality of the exploration data and to give more recognition to the variables affecting the interpretation of the data. —*from* Author's summary

04592 **Cormier, R. F.** Radiometric dating of the Coldbrook Group of southern New Brunswick, Canada: Canadian Jour. Earth Sci., v. 6, no. 3, p. 393-398, illus., tables, 1969.

These volcanic rocks are overlain by Lower Cambrian rocks. Rb-Sr dates suggest two isochron ages. One, with Rb-87/Sr-86 values less than about 1.0, has an age of 750 ± 80 m.y. The other has a ratio more than 1.0 and is about 370 ± 39 m.y. The 750 m.y. age is interpreted as the age of extrusion of the Coldbrook volcanics, and the 370 m.y. date appears to be secondary and is associated with metamorphism of the Coldbrook Group. This age is correlated with the Acadian orogeny, which strongly deformed this part of the northern Appalachians in Middle and Late Devonian time. —*from* Author's abstract

04839 **Correns, C. W.** The discovery of the chemical elements; the history of geochemistry; definitions of geochemistry, Chap. 1 *in* Handbook of geochemistry, V. 1 (K. H. Wedepohl, editor): Berlin and New York, Springer-Verlag, p. 1-11, illus., tables, 1969.

The history of knowledge about gold and other elements from the days of antiquity and medieval alchemists and the history of geochemistry before and since the first use of the word "Geochemie" in 1838 are traced. The first definition, by Christian Friedrich Schonbein, F. W. Clarke's definition published in 1926, and other published definitions are reported. —MS

04469 **Corte, Arturo E.** Geocryology and engineering, *in* Reviews in engineering geology, V. 2 (D. J. Varnes and George Kiersch, editors): Boulder, Colo., Geol. Soc. America, p. 119-185, illus., tables, 1969.

The experimental approach to study of frozen ground under laboratory conditions reveals that because of the complexity of the problem, it is necessary to limit the number of variables. The role of grain size, gradation, and chemical composition is beginning to be understood. The role of ionic, electrical and surface properties is still in the theoretical stage, waiting for an experimental demonstration. The engineer's experimental approach to the problem of frost action reveals the magnitude of frost-heaving forces, and possible means for counteracting them. An applied engineering approach is to alter nature's conditions in order to decrease or suppress a detrimental process. The chemical treatment of soils seems to be a promising area of research. Considering the complexity of the problem of frost behavior, the present engineering criteria seem to be the adequate solution. —*from* Author's conclusions

04534 **Cotera, Augustus S., Jr.** Petrology and petrography of the Tesnus Formation, *in* A guidebook to the stratigraphy, sedimentary structures and origin of flysch and preflysch rocks of the Marathon basin, Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 66-71, 1969.

This is a thick sequence of sandstone and shale, 300 feet thick in the northwestern area, and mostly shale, and 6200 feet thick in the southeast where it is only half shale. The sandstones are mostly fine grained and argillaceous. Only spicules, Radiolaria, and conodonts are present, and these are confined to the shale beds. Plant fragments are locally abundant in the upper part. The conodonts are Late Mississippian and the plants Early Pennsylvanian. Further subdivision of the formation is based upon petrographical differences in the sandstones. The formation was deposited in an area of pronounced tectonic activity, and the source of the detritus was to the southeast. —HRC

04890 **Cotteral, Joseph A.; Norris, Dan P.** Septic tank systems: Am. Soc. Civil Engineers Proc., v. 95, paper 6735, Jour. Sanitary Eng. Div., no. SA4, p. 715-746, illus., tables, 1969.

A review of history and theory of septic tank systems [and case of Marin County, Calif.] allows the establishment of guidelines for design and construction of satisfactory and economical systems. It is recommended that a single drainfield design loading rate be applied to all installations meeting minimum topographical and geological requirements. control should be exercised by a county regulatory agency, and based upon engineering control of design in lieu of a codified approach. —*from* ASCE abstract

04790 **Cousminer, Harold L.** An information system in micropaleontology: Geoscience Inf. Soc. Proc., v. 1, p. 13-17, 1969.

An information storage and retrieval system for micropaleontology is being developed according to a multi-phase plan. The information forms a natural hierarchy; however, the documents have a great range in depth of data. Specialized indexing must be based on a controlled vocabulary. Existing information systems have been examined, and their common direction is reflected in similarities of data elements. Implementation of the system could begin in 1968. —*from* Geosci. Inf. abstract

04667 **Cox, Allan.** Confidence limits for the precision parameter: Royal Astron. Soc. Geophys. Jour., v. 17, no. 5, p. 545-549, tables, 1969.

Confidence limits are calculated for the precision parameter κ used in the analysis of palaeomagnetic data and for the angular standard deviation σ. A set of tables for 95 percent and 99 percent confidence limits is presented. —Author's abstract

04445 **Craig, Harmon.** Density and refractive index hysteresis in compressed silicate glasses: Jour. Geophys. Research, v. 74, no. 20, p. 4910-4920, illus., table, 1969.

The increased refractive index of diopside and albite glass, quenched from liquidus temperatures at pressures to 50 kb, can be accurately calculated from compressibility data on the crystals at 25°C and the Lorentz-Lorenz refraction law. Results indicate that the pressure effect is locked in by configurational trapping on cooling through the glass point, but thermal relaxation takes place with the thermal expansion coefficient characteristic of the applied pressure. Permanent compression of glasses at temperatures below the glass point should be that predicted at load pressure and (1) 25°C, if temperature is released before pressure, or (2) run temperature, if pressure is released before temperature, because thermal relaxation then takes place with the low-pressure thermal expansion coefficient. —*from* Author's abstract

Crain, I. K. *See* Gray, N. H. 04683

04656 **Cramer, Fritz H.** Possible implications for Silurian paleogeography from phytoplankton assemblages of the Rose Hill and Tuscarora of Pennsylvania: Jour. Paleontology, v. 43, no. 2, p. 485-491, illus., 1969.

Silurian phytoplankton and chitinozoans are abundant in shales of the upper Lower Silurian Rose Hill Formation, and near the top of the underlying Tuscarora Formation near Millerstown, Pa. Among these are two new acritarch species, *Baltisphaeridi-*

um maravillosum and *B. monterrosae*, and one new chitinozoan species, *Conochitinia, monterrosae*. Distribution of the presently known mid-Silurian acritarch assemblages in the area bordering the Atlantic suggests the existence of two phytoplankton provinces, the *Deunffia furcata* province and the *Veryhachium, carminae* province. The two biofacies are assumed to reflect paleoclimatic differences, the climate of the *D. furcata* province supposedly the warmer of the two. —SHM

04772 **Cramer, Howard Ross.** Index to the Bulletin and other publications of the Georgia Academy of Science, 1922-1967: [Atlanta, Ga.] Georgia Acad. Sci., 264 p., 1969.

This index, which includes all publications of the Georgia Academy of Science from its founding in 1922 through 1967, is divided into two parts: (1) papers from the Bulletin of the Georgia Academy of Science, V. 1-25 (1943-67); (2) proceedings of the annual meetings of the Academy (1922-46), which were issued before the proceedings began to be published in the Bulletin. Both parts of the index are divided into: author, subject and title, systematic, and academy affairs. —MCM

Creager, Joe S. *See* McManus, Dean A. 04423

04394 **Cronan, D. S.** Chemical and mineralogical aspects of submarine ferromanganese deposits [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 130, 1969.

04580 **Cronan, D. S.; Tooms, J. S.** The geochemistry of manganese nodules and associated pelagic deposits from the Pacific and Indian Oceans: Deep-Sea Research, v. 16, no. 4, p. 335-359, illus., tables, 1969.

Chemical and mineralogic analyses of manganese nodules from a large number of widely spaced localities in the Pacific [including area off U.S. and Central America] and Indian Oceans have shown that their mineralogy and chemical composition vary both areally and with depth of formation. This results from a number of factors, important among which are: their proximity to continental or volcanic sources of elements; the chemical environment of deposition, including degree of oxygenation; and local factors such as upward migration of reduced manganese in sediments from certain areas. Subsurface nodules appear to share the chemical characteristics of their surface counterparts, especially those from volcanic areas where subsurface sources of elements are important. —*from* Authors' abstract

Crowder, D. F. *See* Tabor, R. W. 04660

Currie, J. B. *See* Boyd, J. M. 04914

04346 **Currie, K. L.; Ferguson, J.** A comparison of the alkaline carbonatite complexes at Brent and Callander Bay, Ontario [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 130, 1969.

Dachille, Frank. *See* Vezzoli, Gary C. 04935

04922 **Dainelli, Pietro.** Enrico Marchesini (1911-1968): Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 2017-2018, portrait, 1969.

04524 **Dallas Geological Society; Moore, Clyde H., Jr.** (editor). A guidebook to the depositional environments and depositional history, Lower Cretaceous shallow shelf carbonate sequence, west-central Texas—AAPG-SEPM Ann. Mtg., Dallas, Tex., 1969: Dallas, Texas., Dallas Geol. Soc., 135 p., illus., 1969.

This guidebook contains five papers dealing with the general topic, and road logs for a three-day field trip; each is cited separately. The first day of the trip is from Comanche to Abilene and makes four stops; the second day is from Abilene to Sweetwater and makes five stops. The third day is from Sweetwater to Robert Lee and makes two stops. Preliminary results of an integrated geological study of the Lower Cretaceous carbonate sequence indicate a history of carbonate deposition in shallow marine waters, well shoreward from the edge of the shelf. —HRC

04539 **Dallas Geological Society; Brown, L. Frank, Jr.; Wermund, E. G.** (editors). A guidebook to the Late Pennsylvanian shelf sediments, north-central Texas—AAPG-SEPM, Ann. Mtg., Dallas, Tex., 1969: Dallas, Tex., Dallas Geol. Soc., 69 p., illus., tables, geol. map, 1969.

This field trip was held in conjunction with the AAPG's and SEPM's annual meetings in Dallas in April 1969. There are four papers of a general nature about the Pennsylvanian rocks of the region and road logs and guides for two days of field trips which include nine stops; each article is cited separately. —HRC

04540 **Dallas Geological Society; McBride, Earle F.** (editor). A guidebook to the stratigraphy, sedimentary structures and origin of flysch and pre-flysch rocks of the Marathon basin, Texas—AAPG-SEPM, Ann. Mtg., Dallas, Tex., 1969: Dallas, Tex., Dallas Geol. Soc., 104 p., illus., 1969.

This guidebook contains twelve papers dealing with the various sedimentary petrologic aspects of the formations in the area, and a field trip road log with nine stops. Each article is cited separately by author. The pre-Permian rocks of the Marathon uplift region is the general topic, with the emphasis being placed upon the role of the geosyncline in the sedimentary environment of the various rock units. —HRC

Danö, Marianne. *See* Andersen, E. Krogh.04907

04852 **Dansgaard, W.; Johnson, S. J.; Möller, J.; Langway, C. C., Jr.** One thousand centuries of climatic record from Camp Century on the Greenland Ice Sheet: Science, v. 166, no. 3903, p. 377-381, illus., 1969.

A correlation of time with depth has been evaluated for the Camp Century, Greenland, 1,390 m deep ice core. Oxygen isotopes in approximately 1,600 samples throughout the core have been analyzed. Long-term variations in the isotopic composition of the ice reflect the climatic changes during the past nearly 100,000 years. Climatic oscillations with periods of 120, 940, and 13,000 years are observed. —Authors' abstract

04856 **Dansgaard, W.; Tauber, Henrik.** Glacier oxygen-18 content and Pleistocene ocean temperatures: Science, v. 166, no. 3904, p. 499-502, illus., tables, 1969.

The mean O-18 content of continental ice sheets during the last glacial maximum is estimated as -30 per mille or less, and the consequent change in the isotopic composition of the oceans at that time as 1.2 per mille or more. This means that at least 70 percent of the 0-18 variations found in shells of planktonic foraminifera from deep-sea cores between times of glacial maximums and minimums are due to isotopic changes in ocean water, and at most 30 percent to changes in ocean surface temperature. Hence, Emiliani's "paleotemperature" curve depicts the amount of ice on the continents in excess of that present today. —*from* Authors' abstract

04634 **Das, H. A.; vanRaaphorst, J. G.; Umans, H. J. L. M.** Routine determinations of Al, K, Cr, and Sn in geochemistry by neutron activation analysis, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 291-301, illus., tables, 1969.

Procedures used in the Netherlands Central Reactor laboratory for neutron activation analysis of Al, K, Cr, and Sn in silicate rock samples are discussed. Greater detail is given for analysis of Al and K; some experimental results are tabulated. —VSN

Das, M. Sankar. *See* Parekh, P. P. 04627

Davis, E. F. *See* Durrell, Cordell. 04918

Davis, G. H. *See* Poland, J. F. 04470

Davis, G. L. *See* Brooks, C. 04340

04864 **Dawes, Peter R.** Age and correlation of supracrustal rocks in the Frederikshaabs Isblink area, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 31-33, 1969.

Metavolcanic rocks on Dalagers Nunatakker are composed of pillow lavas, pyroclastics, hornblende schists, metagabbro layers, and ultrabasics; these overlie granite and granodioritic gneiss, with a transition zone between the two groups. North of Isblink, another metavolcanic section occurs in the amphibolite facies, the grade of the surrounding gneisses. The two terranes are of the same age; both have similar characteristics and identical relationships with the gneisses, but both are younger than the gneiss basement. Dikes in the gneisses are similar to dikes in known Precambrian rocks nearby, but are not present in the metavolcanics. —HRC

04748 **Deep-Sea Drilling Project.** (Scientific Staff). Deep-Sea Drilling Project, Leg 5: Geotimes, v. 14, no. 7, p. 19-20, illus., table, 1969.

The Leg 5 track from San Diego to Honolulu included 12 drilling sites from which 869 m of core were recovered. Main objectives were to examine the magnetic anomaly pattern in the Pioneer-Mendocino fracture zone area, and to determine by the sediment record on a north-south profile, the history of the Equatorial Current System and the North Pacific Gyral. Basaltic basement was sampled at six sites, and basal sediment as often as possible, to compare the paleontological age with that inferred from the magnetic anomaly. Comparison shows general agreement of ages with some discrepancies. The cool-water foraminifera sequences have affinities with upper Miocene to Pleistocene faunas from New Zealand. On Leg 7, at least one hole will be drilled where the Darwin Rise may have existed. —ESL

04913 **Deere, R. E.; Bayliss, P.** Mineralogy of the Lower Jurassic in west-central Alberta: Bull. Canadian Petroleum Geology, v. 17, no. 2, p. 133-153, illus., tables, 1969.

The Lower Jurassic in the Rocky Mtn. House area includes the lower part of the Fernie Formation, which may be subdivided into the Nordegg and Poker Chip Shale Members. These units were studied by X-ray diffraction. Quartz, calcite, and dolomite are the essential minerals of the Nordegg, with pyrite, siderite, and bituminous matter as accessories. Three major facies can be identified: a dolomitic sandstone in the east, passing westward into a bioclastic limestone, and farther west to a chert. Source of the silica could have been from volcanic ash from central British Columbia, or carried in solution by streams flowing off the Precambrian Shield. Mineralogy of the Poker Chip Shale Member is less variable. No facies relationships were observed, but a depositional environment similar to the Nordegg is suggested. —*from* Authors' abstract

04395 **Deines, P.; Gold, D. P.** The distribution of carbon and oxygen isotopes in the carbonates of the Oka carbonatite, Quebec, Canada [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 131, 1969.

04752 **Delevoryas, T.** Glossopterid leaves from the Middle Jurassic of Oaxaca, Mexico: Science, v. 165, no. 3896, p. 895-896, illus., 1969.

Leaves indistinguishable from those of the late Paleozoic genus Glossopteris occur in Middle Jurassic beds in the State of Oaxaca, Mexico. If they are biologically related to the Permo-Carboniferous Glossopteris, the occurrence in Mexico is the latest report of the genus. Alternatively, these leaves may have belonged to another group of plants with foliage similar to that of Glossopteris, but with a different reproductive structure. —Author's abstract

04347 **Dence, M. R.** Structure of the Brent Crater, Ontario [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 131, 1969.

04988 **Denison, Rodger E.; Hetherington, E. A., Jr.** Basement rocks in far west Texas and south-central New Mexico, *in* Border stratigraphy symposium—AAAS S.W. and Rocky Mtn. Div., 44th Ann. Mtg., El Paso, Tex., 1968: New Mexico Bur. Mines and Mineral Resources Circ. 104, p. 1-16, illus., tables, 1969.

Far west Texas and south-central New Mexico contain eight areas of Precambrian exposures, and many wells penetrate these strata. Twenty-four isotopic ages show the oldest rocks to be the San Andres Mountain trend, largely granitic rocks 1,350 m.y. old. The Carrizo Mountain Group in the Van Horn area is 1,240 m.y., was originally volcanic and metamorphosed at about 950 m.y. The granite at Pajarito Peak, Otero County, New Mex., is 1,170 m.y. The Castner-Allamore carbonate rocks and the Hazel-Llanoria sandstones and shales, together with their subsurface equivalents, were deposited over a large area accompanied by basalt and diabase injections; granite and rhyolite in the Franklin Mountains were emplaced at the same time (950 m.y.). The igneous activity is the youngest Precambrian event in the area and metamorphosed the slightly older sedimentary rocks. —*from* Authors' abstract

Dennen, W. H. *See* Blackburn, W. H. 04342

04601 **Derr, John S.** Internal structure of the Earth inferred from free oscillations: Jour. Geophys. Research, v. 74, no. 22, p. 5202-5220, illus., tables, 1969.

A new set of weighted means of observed periods of free oscillations is used to establish an Earth model by least squares inversion. First, geophysical arguments that are generally independent of inferences from free oscillations are used to develop an approximate model, and then inversion is used to derive from it a new model, DI-11, which fits the observed periods with an overall rms deviation of only 0.61 sec. DI-11 is characterized by a rapid increase in density at 500 to 800 km, an Adams-Williamson density below 1,100 km, a density jump of 2 g per cu cm at the base of the outer core, and a shear velocity of 2.18 kmps in the inner core. The existence of a solid inner core gets some support from observations of free oscillations. —*from* Author's abstract

04659 **Dever, Garland R., Jr.; McGrain, Preston.** High-calcium and low-magnesium limestone resources in the region of the lower Cumberland, Tennessee, and Ohio Valleys, western Kentucky: Kentucky Geol. Survey, ser. 10, Bull. 5, 192 p., illus., tables, 1969.

Detailed chemical analyses of approximately 1,700 ft-by-ft samples from 21 locations in 8 western Kentucky counties establish the presence of extensive limestone deposits of high chemical purity; average calcium carbonate content in ledges of operable thickness ranges from 95.47-98.2 percent. These limestones warrant consideration as raw material for metallurgical, chemical, and special industrial uses and are well located for development. Purest stone is in the Warsaw and Ste. Genevieve Limestones of Late Mississippian age. Stratigraphic studies show that general correlations exist between established deposits, and indicate favorable zones within the two formations for further exploration. —*from* Authors' abstract

04631 **DeVoe, James R.; LaFleur, Philip D.** (editors). Modern trends in activation analysis, V. 1-2—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, 1334 p., illus., tables, 1969.

Volume 1 contains texts of two invited plenary lectures, one on the applications of activation analysis and one on radiochemical separations, as well as contributed papers, remarks by honored guests, and synopses of discussion sessions by each chairman. Topics covered include applications of activation analysis in the environmental sciences, biology, medicine, archaeology, criminology, geochemistry, geology, and industry. Volume 2 contains texts of three plenary lectures, one on nuclear reactions, one on radiation detectors and data processing, and one on computation methods in activation analysis. Contributed papers, remarks by honored guests, and synopses of discussion sessions are included. Topics covered include nuclear reactions in activation analysis, radiation detectors, data handling and processing, computation methods, error analysis, and information retrieval. —*from* Authors' abstract

04786 **deWaard, Dirk.** Metamorphism and magmatism in the charnockite terrane of the Adirondack Highlands, U.S.A., *in* Internat. Geol. Cong., 22d, New Delhi 1964, Proc., Sec. 13, Charnockites: Calcutta, India, Internat. Geol. Cong. Organising Comm., p. 185-205, illus., tables, 1964 [1969].

Geologic reinterpretation of the Adirondack Highlands emphasizes high-grade metamorphic petrogenesis and two-cycle Precambrian orogenesis. The tectonic pattern is described. Charnockites occur both in the basement complex and in the supracrustal sequence. They developed by high-grade metamorphism during the Grenville orogeny from quartzofeldspathic rocks of diverse origin and low water content. The basement charnockites in part are closely associated with meta-anorthosite and metanorite, and probably are of related premetamorphic origin; others may have been pre-Grenville batholiths. The supracrustal charnockites may have been acidic volcanic flows. Granitic magmatism during the Grenville orogeny was limited. Predominantly dry conditions prevented large-scale anatexis. —DBV

Dickerson, D. R. *See* Stevenson, D. L. 04943

Dickey, Parke A. *See* Jam L., Pedro. 04712

Dickinson, William R. *See* Hatherton, Trevor. 04597

04700 **Dilcher, David L.; Mehrotra, Bharati.** A study of leaf compressions of *Knightiophyllum* from Eocene deposits of southeastern North America: Am. Jour. Botany, v. 56, no. 8, p. 936-943, illus., 1969.

A study was made of the gross morphological characters and cuticular features of several fossil leaves of *Knightiophyllum wilcoxianum* Berry. These fossil leaves were collected from Eocene deposits exposed in three clay pits in western Tennessee. This investigation refutes the relationship of *Knightiophyllum wilcoxianum* to the modern genus *Knightia* and the family Proteaceae as suggested by E. W. Berry. —Authors' abstract

04473 **Dirmeyer, R. D., Jr.** Clay as a canal sealant, *in* Reviews in engineering geology, V. 2 (D. J. Varnes and George Kiersch, editors): Boulder, Colo., Geol. Soc. America, p. 59-79, illus., table, 1969.

This paper traces the development of water-borne clay sealants for canals, from natural silting to the recently developed methods of sediment-sealing with bentonite. In general, the water-borne clays are best for sealing coarsely rocky to gravelly canal bed materials. Less favorable results are obtained when clays are used for sealing fine-grained silty to sandy canal materials. Lack of penetration and short life are the main problems with clays used for sealing fine-grained soils. —*from* Author's abstract

04887 **Dobrin, M. B.** Optical processing of underground sound waves in seismic exploration for oil: Appl. Optics, v. 8, no. 8, p. 1551-1557, illus., 1969.

When coherent light from a laser beam is passed through a transparency on which pictorial information is impressed, the information acts as a complex grating to produce a Fraunhofer diffraction pattern, a two-dimensional Fourier transform or power spectrum of the information. By properly obstructing light in the transform, one can filter out undesired spatial frequencies or directions of inclination on the original picture. Widespread commercial application has been to analysis and filtering of seismic reflection records made in exploration for oil. Removal of undesired noise from seismic recordings can often be accomplished more economically by optical filtering than by digital and electrical analog techniques; use for analysis and solution of geological problems is illustrated. Advantages of optical processing are economy, flexibility, and convenience of monitoring. —*from* Author's abstract

05002 **Dodge, F. C. W.; Smith, V. C.; Mays, R. E.** Biotites from granitic rocks of the central Sierra Nevada batholith, California: Jour. Petrology, v. 10, no. 2, p. 250-271, illus., tables, 1969.

When studied in conjunction with experimental data on biotite stabilities and estimated positions of biotite solid solutions for different oxygen buffers, the compositional trend of the biotites analyzed indicates that oxygen fugacities in magmas during biotite crystallization were near but slightly higher than those of the Ni-NiO buffer. The poor correlation between the $Fe/(Fe + Mg)$ ratio and other elements suggests that, in addition to temperature of formation, factors such as the composition of

the source magmas, compositions of associated minerals, and post-crystallization physicochemical conditions may also have exerted an influence on the biotite compositions. —MS

04515 **Doell, Richard R.** Paleomagnetism of the Kau volcanic series, Hawaii: Jour. Geophys. Research, v. 74, no. 20, p. 4857-4868, illus., tables, 1969.

Paleomagnetic studies of 54 superposed lavas from the northwest wall of Mokuaweoweo, Mauna Loa, Hawaii, show that changes in direction of the geomagnetic field were very small during the time of extrusion of these lavas. After reasonable estimates are made for the time involved (a period of several thousands of years, occurring sometime after 10,000 years ago), it is tentatively concluded that secular variation due to nondipole field changes in the central Pacific Ocean is very small and can be described by an angular deviation for virtual poles of only 0.05 radians (3°). In combination with other Hawaiian paleomagnetic studies representing longer time intervals, this leads to an estimated agnular deviation of 0.20 radians (12°) for "wobble" of the main dipole during the Brunhes magnetic polarity epoch. – Author's abstract

04587 **Dóndoli B., César.** Información general geológico – Petrográfica y mineralógica sobre Costa Rica: Costa Rica Inst. Geog. Nac. Informe Semestral, July-Dec. 1968, p. 18-30, 1969.

The general geology of Costa Rica is summarized, the various types of igneous, metamorphic, and sedimentary rocks to be found are described briefly, and mineral resources are discussed in general and by region. —VSN

04722 **Dott, Robert H., Sr.** Richard Hughs (1889-1969): Am. Assoc. Petroleum Geologists Bull., v. 53, no. 10, p. 2197-2198, portrait, 1969.

04862 **Douglass, P. M.; Voight, B.** Anisotropy of granites—A reflection of microscopic fabric: Geotechnique, v. 19, no. 3, p. 376-398, illus., tables, 1969.

Results are given of an inquiry into mechanical anisotropy of three North American granites (Barre, Stanstead, Laurentian). Assumption of an ellipsoidal distribution of elastic moduli was found to be justified; data suggest that orthotropic elastic idealization may be suitable provided that nonlinearity is accounted for. Engineering predictions for these rocks, if based on idealization of linear isotropic behavior, could lead to serious error. Microscopic fabric analysis shows that the cause of both nonlinear and anisotropic behavior is mechanistically the same, an effect produced by small preferentially oriented cracks. For all cases, directions of high compliance and low cleavage resistance could be related to microfractures in quartz grains; this fabric element can provide a rapid and inexpensive method for evaluating anisotropy. —*from* Authors' abstract

04766 **Dover, James H.** Bedrock geology of the Pioneer Mountains, Blaine and Custer Counties, central Idaho: Idaho Bur. Mines and Geology Pamph. 142, 61 p., illus., geol. map, 1969.

Three major units of crystalline rocks form the autochthonous core of the Pioneer Mountains. The Wildhorse Canyon Migmatitic Gneiss Complex, predominantly of sedimentary derivation, forms two gneiss domes. Most minor structures were formed at the time of doming. About 7,000 feet of metasedimentary rocks overlying the migmatites have undergone regional, synkinematic, and isochemical metamorphism, at low pressure. Recrystallized pre- or synmetamorphic thrust faults imbricate this sequence. An intrusive sheet separates the two metamorphic units, being intruded during a waning stage of the same episode of intense regional, orogenic metamorphism that affected the wall rocks. This pluton is identical to marginal facies of the Idaho batholith. K-Ar dates indicate that the Middle Cretaceous may mark a time of diminishing Mesozoic orogeny. —*from* Author's abstract

04702 **Dowds, John P.** Oil rocks, information theory, Markov chains, entropy, *in* Operations research and computer applications in the mineral industries: Colorado School Mines Quart., v. 64, no. 3, p. 275-293, illus., 1969.

A model is proposed to simulate rock distributions as a function of Markov processes. The uncertainty or variety present in the lithologic Markov chains is measured as the entropy according to Shannon's information theory. A simple checkerboard pattern is used to demonstrate how the areal distribution of a geologic system can be described by conditional probabilities in the Markov processes as well as those found in the Bayesian analyses. —KAF

04654 **Dowling, Forrest Leroy.** A magnetotelluric investigation of the crust and upper mantle across the Wisconsin Arch [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 262B, 1969.

Dran, J. C. *See* Gordon, G. E. 04614

04640 **Drever, James Irving.** Electrophoresis and the study of clay minerals in recent sediments, (Pts. 1-2) [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 254B, 1969.

04364 **Drummond, A. D.; Trotter, J.; Thompson, R. M.; Gower, J. A.** Neyite—A new sulphosalt from Alice Arm, British Columbia: Canadian Mineralogist, v. 10, pt. 1, p. 90-96, tables, 1969.

Neyite, $Pb_7Bi_6(Cu,Ag)_2S_{17}$, is a new sulfosalt mineral occurring as needles and acicular aggregates in late vuggy quartz veins with pyrite, galena, sphalerite, chalcopyrite, aikinite, cosalite, and tetrahedrite. These veins are later than the quartz-molybdenite veins of Lime Creek molybdenum deposit near Alice Arm, B.C. The mineral is lead grey with bright metallic luster and Prussian blue tarnish on exposure; it is brittle with conchoidal fracture, and has a hardness of 2.5 with specific gravity of 7.02. It has monoclinic symmetry and $a = 37.5 \pm 0.1$, $b = 4.07 \pm 0.01$, $c = 41.6 \pm 0.1$ A, and $\beta = 96.8° \pm 0.3°$. Strongest lines of the X-ray powder diffraction pattern and reactions to standard etch tests are given. —*from* Authors' abstract

Duquette, G. *See* Gunn, B. M. 04391

04678 **Durden, Christopher J.** Pennsylvanian correlation using blattoid insects: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1159-1177, illus., 1969.

The stratigraphic distribution of blattoid (cockroach-like) insect genera in the type Pennsylvanian permits the zoning of lacustrine members in this sequence. When taken with the associated floras and the intercalated marine faunas, blattoid fossils permit fine correlation between the name-type Pennsylvanian of Pennsylvania, the goniatite-bearing Upper Carboniferous of Europe, the fusuline-bearing Pennsylvanian of Kansas, and other contemporaneous sequences, especially those of exclusively limnic facies such as the Morien, Pictou, and Narragansett Basins. Application of epochal ages, developed in Europe, to the type and other regions of the Pennsylvanian is now possible. The time distribution of the major genera is presented with a time-stratigraphic plot of data control points in the type region, and a documentation of the relevant systematics is appended. —Author's abstract

04918 **Durrell, Cordell; Davis, E. F.** Frank Samuel Hudson (1890-1967): Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 2012, portrait, 1969.

Eberlein, G. Donald. *See* Erd, Richard C. 04407

Eckel, Edwin B. *See* Plafker, George. 04454

Edgar, A. D. *See* Platt, R. G. 04371

04745 **Edmunds, William E.** Revised lithostratigraphic nomenclature of the Pottsville and Allegheny Groups (Pennsylvanian), Clearfield County, Pennsylvania: Pennsylvania Geol. Survey Inf. Circ. 61, 36 p., illus., 1969.

Seven new formations are erected for use in dealing initially with the stratigraphy of the lower part of the Pennsylvanian rocks of Clearfield County; type sections are presented. The new formations together with presumed relation to Allegheny and

Pottsville Groups are generalized: Allegheny Group (base Clarion no. 1 coal to top upper Freeport coal)—Glen Richey, Laurel Run, Mineral Springs, Millstone Run, and Clearfield Formations; Pottsville Group (all Pennsylvanian rocks below Clarion no. 1 coal, base is the Mississippian-Pennsylvanian unconformity)—Curwensville and Elliot Park Formations. —*from* Author's abstract

04636 **Ehmann, W. D.; McKown, D. M.** The nondestructive determination of iridium in meteorites using gamma-gamma coincidence spectrometry, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 308-314, illus., tables, 1969.

A nondestructive procedure for determination of Ir in meteorites containing at least 0.1 ppm Ir is described which utilizes neutron activation followed by gamma-gamma coincidence spectrometry. The procedure eliminates problems associated with radiochemical separation of Ir. If errors due to pre-irradiation contamination, irradiation variables, and coincidence counting arrangement are evaluated to establish validity of the data, the technique may be used to evaluate various chemical procedures previously employed. —*from* Authors' introduction

04348 **Elam, Jack G.; Chuber, Stewart.** (editors). Cyclic sedimentation in the Permian basin—Symposium, Midland, Tex., 1967: West Texas Geol. Soc. Pub. 69-56, 203 p., illus., table, 1969.

This volume contains 11 papers and 2 abstracts (all cited separately) on cyclic sedimentation presented at a symposium organized by the West Texas Geological Society in Midland, Texas, on October 19-20, 1967. Cyclicity may result from eustatic sea level changes, megatectonic movements, or sedimentary distribution variation. —KAF

04475 **Elam, Jack G.** The tectonic style in the Permian Basin and its relationship to cyclicity, *in* Cyclic sedimentation in the Permian Basin—Symposium, Midland, Tex., 1967: West Texas Geol. Soc. Pub. 69-56, p. 55-79, illus., 1969.

The tectonic style in the Permian Basin is that of differential vertical uplift of the basement. The orientation of the stress system which caused the structures to grow differed markedly from that which caused basinal subsidence. There was both intermittent structural uplift and basinal subsidence and some of the apparent sea-level fluctuations related to cyclic sedimentation must have been caused by these structural phenomena. In some areas, structural relief must have been greater than at present. Failure to understand the tectonic style has caused many problems in deciphering the geological history of the basin. An alternative explanation is offered for the so-called "starved" Midland basin, that of broad regional upwarping and erosion in late Cisco time. The motive force for upwarping and subsidence may be related to the ebb and flow of mantle convection cells.—Author's abstract

04582 **Ellis, Brooks F.; Messina, Angelina R.; Charmatz, Richard; Ronai, Lili E.** Catalogue of index smaller foraminifera—V. 3, Mesozoic-Tertiary benthonic foraminifera: New York, Am. Mus. Nat. History Spec. Pub., [795] p., illus., 1969.

This is the third volume of a three-volume catalog of index species selected on the basis of wide geographic distribution and restricted geologic range (V. 1, 1968, and V. 2, 1969, containing Paleozoic foraminifera and Cretaceous and Tertiary planktonic foraminifera, are cited in Abstracts of North American Geology for Jan. 1969 and Nov. 1969). Volume 3 contains 190 species belonging to 92 genera of Mesozoic and Tertiary benthonic foraminifera. Species are arranged alphabetically under the genera to which they are assigned herein; families and higher taxa are not designated. For each species, the bibliographic citations are given in order of publication date, with generic and specific name, illustrations, ages, and localities given as designated by each author. An index to species names lists the generic assignment used herein, followed by other combinations. —VMJ

04877 **Ellitsgaard-Rasmussen, K.** General review of the Survey's activities in 1968, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 5-10, illus., 1969.

This annual progress report for the year 1968 contains 21 short articles, each of which is cited individually by author. The topics range from Precambrian mapping problems to modern glacial studies, and include some age dating. —HRC

04359 **ElPaso Geological Society; SEPM Permian Basin Sec.** The Ordovician symposium, 3d annual field trip, 1969: El Paso, Tex., El Paso Geol. Soc., 162 p., illus., 1969.

This guidebook for the 1969 field trip through the Ordovician section exposed in the southern Franklin Mountains of Texas and New Mexico includes a road log and ten papers cited separately on the Paleozoic stratigraphy of the Franklin Mountains region. —KAF

04985 **Emery, K. O.** The continental shelves: Sci. American, v. 221, no. 3, p. 106-122, illus., 1969.

This semipopular article summarizes the major known geological features of this economically important part of the sea floor. Shelf regions adjacent to continents are equal in extent to 18 percent of the total land area of the earth. The average depth to the outer edge of the shelf is about 130 meters. Most of the continental shelf was exposed during the peak of the last glacial lowering of the sea level 15,000 years ago. —DWR

04777 **Emiliani, Cesare; Harrison, Christopher G. A.; Swanson, Mary.** Underground nuclear explosions and the control of earthquakes: Science, v. 165, no. 3899, p. 1255-1256, table, 1969.

Underground nuclear explosions trigger significant earthquake activity for at least 32 hours afterward and to distances up to at least 860 kilometers. The proposed Amchitka test may be used to study the feasibility of employing high-yield underground nuclear explosions to release stresses accumulating in the lithosphere. Periodical explosions along active fault zones may be used to prevent disastrous earthquakes. —Authors' abstract

04407 **Erd, Richard C.; Eberlein, G. Donald; Christ, C. L.** Fabianite and its synthetic dimorph, $CaB_3O_5(OH)$—New data: Canadian Mineralogist, v. 10, pt. 1, p. 108-112, tables, 1969.

The structure and other crystallographic properties of the synthetic compound CaB_3O_5 (OH) were reported by Clark et al (1962) and a crystallographic description of the new mineral fabianite, of the same composition, was published by Kuhn et al (1962). In this study the space group and unit-cell parameters of fabianite were determined, and the optical properties and crystal habits of both dimorphs were redetermined. Results are tabulated with those of the previous investigators for comparison. —VSN

04641 **Erickson, Rolfe Craig.** Petrology and geochemistry of the Dos Cabezas Mountains, Cochise County, Arizona [abs.]: Dissert. Abs. Internat. Sec. B, Sci. and Eng., v. 30, no. 1, p. 254B-255B, 1969.

Ethington, R. L. *See* Hintze, L. F. 04432

Euresty, David. *See* Harris, DeVerle P. 04705

Evans, Lanny L. *See* McCormick, J. Edward. 04575

04642 **Evensen, James Millard.** Geology of the central portion of the Aqua Fria mining district, Yavapai County, Arizona [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 255B, 1969.

Ewing, J. I. *See* Collette, B. J. 04727

Ewing, Maurice. *See* Miyashiro, Akiho. 04688

Ewing, Maurice. *See* Miyashiro, Akiho. 04764

04779 **Faas, Richard W.** Analysis of the relationship between acoustic reflectivity and sediment porosity: Geophysics, v. 34, no. 4, p. 546-553, illus., tables, 1969.

Ocean-bottom sediment porosity and acoustic reflectivity are related by a simple linear equation. The equation was derived empirically from data published by several investigations and is valid for a wide variety of sediment types and ocean conditions. The degree of validity of the relationship appears to be excellent as the correlation coefficient between the porosity and acoustic reflectivity is 0.97. —Author's abstract

04767 **Fabbri, Bruno; Vespignani-Balzani, Gian Carla.** Spectrochemical data on some rock standards: Mineralog. et Petrog. Acta 1968, v. 14, p. 105-110, tables, 1969.

Concentrations of Sr, Ba, Fe_2O_3, MgO, MnO, and TiO_2 in nine silicate rock standards were determined by emission spectrography. $CaCO_3$ was used as an internal standard and spectroscopic buffer; each sample was mixed with $CaCO_3$ and graphite. A Hilger E 478 spectrograph with glass optics, and Ilford Chromatic G30 plates were used. Data for each rock standard are tabulated, and compared with available data. —ESL

04629 **Fain, Gilbert.** Signal theory applied to continuous seismic profiling [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 199B, 1969.

Falconer, G. *See* Andrews, J. T. 04687

Fantozzi, Joseph H. *See* Szasz, Stephen E. 04901

04643 **Farkas, Steven Eugene.** Geology of the southern San Mateo Mountains, Socorro and Sierra Counties, New Mexico [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 255B-256B, 1969.

Fawcett, J. J. *See* Rucklidge, J. C. 04350

04362 **Faye, G. H.; Harris, D. C.** On the origin of colour and pleochroism in andalusite from Brazil: Canadian Mineralogist, v. 10, pt. 1, p. 47-56, illus., table, 1969.

A study is reported of the polarized optical absorption spectra of a specimen of andalusite from Brazil. The weakly visible pleochroism of relatively thick *a-b* sections is thought to be the result of variation in the intensity of a u.v.-centered band due to $O^{2-} \rightarrow Fe^{3+}$ charge transfer. Arguments are presented to show why absorption is more intense in the $E \| b$ spectrum. Intense pleochroism of andalusite sections containing the *c*-axis is considered to be the result of $Ti^{3+} \rightarrow Ti^{4+}$ charge transfer via overlapping t_{2g} orbital lobes of adjacent ions located in the chains of octahedra that parallel the *c*-axis. Absorption is at a maximum when polarized light vibrates along the *c*-axis, the direction in which t_{2g} orbital lap occurs. —Author's abstract

04366 **Faye, G. H.** The optical absorption spectrum of tetrahedrally bonded Fe^{3+} in orthoclase: Canadian Mineralogist, v. 10, pt. 1, p. 112-117, illus., 1969.

Optical absorption spectrum measurements and spectral details are presented together with transition assignments and other interpretations for a lemon-yellow gem-quality specimen of iron-rich orthoclase. Only three principal bands—26500, 24000, and 22600 cm^{-1}—are resolved in the spectrum and are tentatively assigned to the $^6A_1 \rightarrow {}^4A_1{}^4E(G)$, $^6A_1 \rightarrow {}^4T_2(G)$ and $^6A_1 \rightarrow {}^4T_1(G)$ transitions, respectively. The resolution of these bands only is due to encroachment into the visible region of intense background absorption centered in the ultraviolet probably due to the $O^{2-} \rightarrow Fe^{3+}$ charge-transfer process. The sharpness of the 26500 cm^{-1} band is consistent with assignment to transition of the first field-independent state. The yellow color is due to absorption of blue light in the 400 to 450 m μ region. —VSN

04420 **Faye, G. H.; Hogarth, D. D.** On the origin of 'reverse pleochroism' of a phlogopite: Canadian Mineralogist, v. 10, pt. 1, p. 25-34, illus., tables, 1969.

The visible spectra of phlogopite with a reversely pleochroic scheme consist essentially of three bands in the 450-550 mμ region superimposed on the wing of a strongly pleochroic band centered in the ultraviolet region. The spectra have their

greatest intensity when polarized light vibrates normal to the cleavage plane, the reverse of micas with normal pleochroic schemes. By comparing the phlogopite spectra with those of an iron orthoclase and $FeCl_4^-$, materials which are known to contain tetrahedrally-coordinated Fe^{3+}, it has been established that the three-band system in the visible region is also due to this ion. The background absorption is considered to be due to an $O^{2-} \rightarrow Fe^{3+}$ charge-transfer band which is most intense when the vibration direction is coincident with the O^{2-} (unbridged)–Fe bond perpendicular to (001) in the iron-bearing tetrahedra.–Authors' abstract

04421 **Faye, G. H.; Nickel, E. H.** On the origin of colour and pleochroism of kyanite: Canadian Mineralogist, v. 10, pt. 1, p. 35-46, illus., table, 1969.

Although the colour and pleochroism of blue kyanite has been attributed to the presence of Ti^{3+} by previous workers, the present study of the polarized absorption spectra of such kyanite indicates that $Fe^{2+} \rightarrow Fe^{3+}$ charge transfer accounts more readily for the optical properties. Experimental evidence is given for the presence of both Fe^{2+} and Fe^{3+} in blue kyanite and proposals are made for the manner in which these ions interact, across octahedral edges, to give rise to a pleochroic absorption band at 16500-1700 cm^{-1}. The direction of maximum intensity of this band correlates directly with the principal optical direction, Z, of kyanite.–Author's abstract

04476 **Feray, Dan E.** Tectonic versus eustatic control of Pennsylvanian cyclical sedimentation in north-central Texas [abs.], *in* Cyclic sedimentation in the Permian Basin—Symposium, Midland, Tex., 1967: West Texas Geol. Soc. Pub. 69-56, p. 81, 1969.

Ferguson, J. *See* Currie, K. L. 04346

04396 **Ferguson, J.** The differentiation of agpaitic magmas–The Ilímaussaq intrusion, South Greenland [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 132, 1969.

Ferguson, R. B. *See* Ribbe, P. H. 04904

04543 **Fernández Peralta, Ricardo.** Estado de los volcanes de Costa Rica: Costa Rica Inst. Geog. Nac. Informe Semestral, July-Dec. 1968, p. 11-12, 1969.

Volcanoes of Costa Rica are listed with comments on the state of activity and condition of the crater. Currently active volcanoes are Rincón de la Vieja, Arenal, Poás, Irazú. Other volcanoes are classified as quiet or extinct.–VSN

04465 **Field, Michael E.; Pilkey, Orrin H.** Feldspar in Atlantic continental margin sands off the southeastern United States: Geol. Soc. America Bull., v. 80, no. 10, p. 2097-2102, illus., table, 1969.

Sand-size sediments on the Atlantic southeastern United States continental margin are generally low in feldspar; this reflects the deeply weathered source area. The feldspar content of sediments indicates that shelf sands are derived mainly from Piedmont Province rivers and that contour currents may be important in distributing continental rise sands. There is no clear indication of significant ice-age subaerial weathering of feldspar on the shelf or on present day beaches. However, the size distribution of feldspar in continental shelf sands compared to the size distribution of feldspar in river sands indicates that the shelf sands have undergone a significant abrasional history subsequent to contribution from rivers.—Authors' abstract

Fields, E. D. *See* Sayers, R. W. 04867

04625 **Filby, Royston H.; Haller, William A.** Activation analysis of geochemical materials using Ge(Li) detectors, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 339-346, illus., tables, 1969.

A method is reported to extend the range of elements that can be determined in rocks, minerals, and meteorites by neutron activation analysis using high resolution Ge(Li) detectors. Short irradiation of samples with rapid transfer to a counting

system permits determination of Al, Mn, Na, V, Ti, Ca and sometimes Mg. Long irradiation followed by a one month decay period allows determination of Sb, Co, Zn, Sc, Cr, Eu, Th, U, Ba, Ta, and Fe. High Na-24 activity in most irradiated silicate rocks and meteorites masks several activation products of K, Ga, Zn, La, Cu, Sr, Ba, Eu, and in some cases Mn; a method is given for determination of these nuclides by dissolution of irradiated samples followed by removal of Na-24 on a sodium specific inorganic ion-exchange. Results for major and trace elements in seven standard rocks are tabulated. —VSN

Fiske, Richard S. *See* Kinoshita, Willie T. 04855

04542 **Flawn, Peter T.** The regional setting of the Marathon salient, *in* A guidebook to the stratigraphy, sedimentary structures and origin of flysch and pre-flysch rocks of the Marathon basin, Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 23-28, illus., modified 1969; originally published 1961 and 1964.

A generalized description of the Ouachita system is given; it extends from at least Mississippi sinuously around the southern edge of the United States, and southward into Mexico. Several salients project northward, of which the Marathon is one. The structural axis is convex toward the foreland; there are complex anticlinoria and synclinoria; folds occur toward the northeast and thrust faults toward the north. The Marathon salient is structurally high with relation to the rest of the surrounding system, and gravity minima are pronounced. The sedimentary rocks are abnormally thick and the foreland facies are included in the frontal zone of the structural belt. Clastic rocks increase and thicken southward, and the foreland is bordered by a deep frontal basin. Folding is post-Pennsylvanian—pre-Permian. —HRC

Flower, R. H. *See* Hintze, L. F. 04432

04834 **Flower, Rosseau H.** Some El Paso guide fossils: New Mexico Bur. Mines and Mineral Resources Mem. 22, p. 3-19, 46-55, illus., 1969.

Fossils from the El Paso group [New Mexico and western Texas], here figured and described, are largely species of some horizons or are of correlative significance. The forms are listed in the table of contents. —*from* Author's abstract

04835 **Flower, Rosseau H.** Fossils from the Smith Basin limestone of the Fort Ann region, New York: New Mexico Bur. Mines and Mineral Resources Mem. 22, p. 21-27, 56-57, illus., 1969.

Eleven species of fossils of the Smith Basin limestone of the Fort Ann region in New York are described and illustrated. The fauna is of late Gasconade age and affinities. —Author's abstract

04836 **Flower, Rosseau H.** Fossils from the Fort Ann formation: New Mexico Bur. Mines and Mineral Resources Mem. 22, p. 29-34, 58-59, illus., 1969.

Commoner fossils of the Fort Ann limestone, exclusive of the cephalopods, are described and illustrated from the southern end of the Champlain Valley, New York. The fauna is of Middle Canadian age; five of the seven species here discussed are new. —Author's abstract

04837 **Flower, Rosseau H.** Merostomes from a Cotter horizon of the El Paso group: New Mexico Bur. Mines and Mineral Resources Mem. 22, p. 35-44, 60-63, illus., 1969.

Silicified merostomes recovered from a faunule of Cotter age in the lower part of the Scenic Drive formation of the El Paso Group constitute four species of the new genus *Lemoneites*, which combines some features known previously in the Aglaspida with others known previously only in some of the Synziphosura. The new family Lemoneitidae is proposed. Affinities of the genus and its bearing on arthropod classification are discussed. —Author's abstract

04433 **Flower, Rousseau H.** Early Paleozoic of New Mexico and the El Paso region, *in* The Ordovician symposium—El Paso Geol. Soc., 3d Ann. Field Trip, 1969: El Paso, Tex., El Paso Geol. Soc., p. 31-101, illus., 1969.

The early Paleozoic section of New Mexico and the El Paso region is described in detail. Interpretation has depended to a large extent upon the fauna. The chronological development of refinements of the geological column of the early Paleozoic of New Mexico is discussed also. —KAF

Fong, D. G. *See* Jambor, J. L. 04363

Forbes, Robert B. *See* Wilson, Charles R. 04449

04571 **Forbes, Robert B.; Barsdate, Robert J.** Trace-element zonation in a native-copper nugget from the McCarthy district, Alaska: Econ. Geology, v. 64, no. 4, p. 455-458, illus., tables, 1969.

Seven copper nuggets had the following trace elements in ppm: Ag, 35-480; Co, trace-12; Cr, trace-9; Fe, 9-358; Mn, trace-6; Ni, 4-12 (plus one with 150); Pb, trace-8; Sb, 60-130; Zn, 4-12. Two samples from Lake Superior gave similar results (though As was not determined), suggesting that similar geochemical processes may generally be involved in the formation of native copper in greenstone. Ag, Sb, and Zn increase toward the center of a large mass drilled from rim to core. —WSW

04857 **Forbes, Robert B.; Hoskin, Charles M.** Dredged trachyte and basalt from Kodiak seamount and the adjacent Aleutian Trench, Alaska: Science, v. 166, no. 3904, p. 502-504, illus., table, 1969.

Blocky fragments of aegirine-augite trachyte (with accompanying ice-rafted gravels) were recovered from the upper slopes of Kodiak Seamount in several dredge hauls. An alkali basalt pillow segment was also dredged from a moat-like depression, at a depth of 5,000 m, near the west base of the seamount. These retrievals confirm the volcanic origin of Kodiak Seamount and further support the view of Engel, Engel, and Havens that the higher elevations of seamounts are composed of alkali basalts of related variants. —Authors' abstract

04721 **Forgotson, James M., Sr.** Well symbols and title blocks on geological maps: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 10, pt. 1, p. 2189-2190, illus., 1969.

The author proposes the use of properly annotated well symbols to give the map user the true well status. The use of title explanations would give the map user a clear idea of relations between structural attitude and productivity of a particular reservoir. —SEF

Foster, Roy W. *See* Kottlowski, Frank E. 04431

Foster, Roy W. *See* Kottlowski, Frank E. 04944

Fowler, Phillip M. *See* Williams, Roy E. 04692

04682 **Fox, Peter E.; Moore, John M., Jr.** Feldspars from Adamant pluton, British Columbia: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1199-1209, illus., tables, 1969.

Adamant pluton is zoned, with a core of pyroxene monzonite transitional outward to hornblende quartz monzonite and biotite-hornblende granodiorite. Zoning resulted from reaction with introduced water and oxygen during regional metamorphism to upper amphibolite facies. Feldspars in the monzonite are orthoclase and andesine of intermediate structural state. Systematic changes in the feldspars comprise: (1) ordering of alkali feldspars toward intermediate microcline, with increase of 2V, decrease of Na and Ca content, and appearance of grid twins; (2) ordering and increase in Na content of plagioclase. The most ordered feldspars, with the highest Na distribution coefficient, are found in peripheral granodiorite and in pegmatite cutting the quartz monzonite. The feldspar data support the model proposed for the evolution of the pluton. —*from* Authors' abstract

Franklin, E. G. *See* Johnson, S. W. 04516

04464 **Freeman, Tom.** Cement-composition discontinuity in the Cambrian of Texas and its stratigraphic implications: Geol. Soc. America Bull., v. 80, no. 10, p. 2095-2096, illus., 1969.

Cement in the Lion Mountain Sandstone Member is principally quartz, whereas cement in the overlying Welge Sandstone Member is principally calcite. More important, microprobe analysis shows an abrupt discontinuity in the minor-element [iron-magnesium] composition of calcite cements on either side of the contact. This discontinuity can best be explained by a hiatus [suggested by paleontological evidence]: —Author's abstract

04397 **Friedlaender, C. G.** Brownian movement in quartz [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 132, 1969.

Friedlaender, C. G. I. *See* Sinha, R. P. 04354

04398 **Frisch, T.** Chemical variations among the amphiboles of Shefford Mountain, a Monteregian intrusion in southern Quebec [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 132, 1969.

04400 **Froese, E.** Calculated phase diagram of the system $CaCO_3$-$SrCO_3$[abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 133, 1969.

04820 **Fuller, J. G. C. M.; Porter, J. W.** Evaporites and carbonates—Two Devonian basins of western Canada: Bull. Canadian Petroleum Geology, v. 17, no. 2, p. 182-193, illus., 1969.

Evaporites and carbonates deposited in two Devonian basins of western Canada occur as peripheral evaporites with basin-filling carbonate, or peripheral carbonate with basin-filling evaporite, and reefs. The Upper Devonian Stettler Formation provides an example of a limestone-filled basin on the periphery of which are evaporites having those characteristics associated with modern sabkhas of the Arabian Gulf. Deposits associated with the first stage of reef growth in Upper Elk Point basin (Middle Devonian) provide an example of the second kind. Sedimentary units were deposited as follows: platform; reef, ending with laminar dolomite on both reef and basin-floor; bituminous calcitic and anhydritic laminites on basin-floor; and laminar halite filling interreef tracts nearly to reef-top level. During calcitic laminite and salt accumulation reefs were subaerially exposed; further reef stages supervened. —*from* Authors' abstract

04584 **Fulweiler, Robert E.; McDougal, Samuel E.** Bedded-ore structures at the Jefferson City mine, Jefferson City, Tennessee [abs.]: Econ. Geology, v. 64, no. 3, p. 348-349, 1969.

Fungaroli, A. A. *See* Hornberger, G. M. 04829

Fyson, W. K. *See* Sikander, A. H. 04798

04622 **Gabelman, John W.** Uranium possibilities in the eastern USA and Canada [abs.]: Mining Eng., v. 21, no. 8, p. 38-39, 1969.

Galloway, W. E. *See* Brown, L. F., Jr. 04523

04717 **Gandhi, S. S.; Grasty, R. L.; Grieve, R. A. F.** The geology and geochronology of the Makkovik Bay area, Labrador: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1019-1035, illus., tables, 1969.

The sedimentary and volcanic formations of the Aillik Series of this area are about 25,000 feet thick. They are folded and intruded by gabbro, diorite, syenite, and abundant granite. K-Ar dates for two gneisses range from 1730 to 1830 m.y. and for metasediments, volcanics, intrusive granite-gneiss and granite, the dates are 1500 to 1600 m.y. A single orogenic cycle is shown by the structures, in which synkinematic

emplacement of granite gneiss as domes and other bodies played an important role. One of the gneisses is a part of the migmatized Archean basement on which the Aillik Series was laid down, and was subsequently involved in the Hudsonian orogeny, about 1600 m.y. ago. The area lies to the northwest of the Grenville front, and has been intruded by diabase dikes corresponding in age to the Grenville orogeny, and by Cambrian lamprophyres. —*from* Authors' abstract

04785 **Garber, M. S.; Wollitz, L. E.** Measuring underground-explosion effects on water levels in surrounding aquifers: Ground Water, v. 7, no. 4, p. 3-7, illus., 1969.

Underground detonations may produce observable effects in surrounding aquifers and wells. The nature and the duration of the effect at any observation point seem to depend on several factors such as the amount of energy released by the detonation, the geologic environment, the position of the buried explosive device in relation to the saturated zone, aquifer characteristics, and the distance from point of detonation. Precise measurement of these effects in wells presented numerous technical problems and resulted in the development of specialized techniques. Initially, these effects were observed by measuring the fluctuation of the free water surface in wells. The current technique employs high-resolution pressure transducers deep in the water column. Pneumatic packers may be used to restrict the movement of water into the well. Data are recorded on high-speed oscillographs. —Authors' abstract

Garbutt, Phillip L. *See* Brooks, Elwood R. 04559

Gasparrini, E. *See* Rucklidge, J. C. 04350

04689 **Gay, S. Parker.** Regional aeromagnetic and gravity linears—Are they significant in mineral exploration? [abs.]: Mining Eng., v. 21, no. 8, p. 42, 1969.

Gehin, C. *See* Kermabon, A. 04751

Gelinas, L. *See* Perrault, G. 04382

04401 **Gelinas, L.** Le diagramme logique de la norme C.I.P.W. [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 133, 1969.

04590 **Gelpi, E.; Nooner, D. W.; Oró, J.** Isoprenoids and other hydrocarbons in terrestrial graphite: Geochim. et Cosmochim. Acta, v. 33, no. 8, p. 959-972, illus., tables, 1969.

Samples of terrestrial graphite from widely separated areas (for example Mexico, Ceylon, Madagascar) were found, with few exceptions, to contain extractable hydrocarbons. These hydrocarbons were classified into nonaromatic and aromatic fractions by silica gel chromatography and each fraction was analyzed by gas chromatography and combined gas chromatography-mass spectrometry. The nonaromatic fractions consisted primarily of straight chain alkanes and branched alkanes including C14 through C22 isoprenoids. The aromatic fractions were almost exclusively alkyl substituted naphthalenes. —Authors' abstract

Gerhard, Lee C. *See* Rocky Mountain Assoc. Geologists. 04958

Gerhard, Lee C. *See* Jurie, Carl A. 04959

Gerhard, Lee C. *See* Lewis, Christopher J. 04960

04747 **Ghisler, Martin; Sharma, P. Vallabh.** On the applicability of magnetic prospecting for chromite in the Fiskenaesset region, West Greenland: Grönlands Geol. Undersögelse Rap. 20, 25 p., illus., tables, 1969.

The chromite deposits of the Fiskenaesset region belong to a metamorphosed igneous complex of stratiform type occurring in the basement gneiss unit of older Precambrian age in West Greenland. Short descriptions and modal compositions of the different rock types are given together with the results of magnetic measurements on 60 rock samples (data shown in tables 1-5). On the basis of known geology and

rock susceptibilities, different models are discussed with respect to the applicability of both an airborne and a ground magnetometer survey. It is concluded that the susceptibility contrasts involved are sufficient for locating favorable host rocks by aeromagnetic survey, but direct magnetic prospecting for chromite horizons predominantly occurring within anorthosites may not be feasible. —Authors' abstract

Gibb, F. G. *See* Rucklidge, J. C. 04350

04368 **Gibbons, R. V.; Papezik, V. S.** Origin of arsenic-antimony mineralization near Moreton's Harbour, northern Newfoundland [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 133-134, 1969.

Gilat, J. *See* Mantel, M. 04617

Gilbert, C. M. *See* Christensen, M. N. 04600

04684 **Gillespie, J. E.; Protz, R.** Evidence for the residual character of two soils, one on granite, the other on limestone in Peterborough County, Ontario: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1217-1225, illus., tables 1969.

The morphology, particle size distribution, and clay mineralogy data of a Methuen soil derived from a granite and a Tweed soil derived from a crystalline limestone are interpreted as supporting the concept that these two soils are residual. Sand mineralogy and elemental analysis of mica support the residual hypothesis.—Authors' abstract

04514 **Gilmour, Ernest H.; Williams, Loren A.** Geology and coal resources of the Foster Creek coal deposit, eastern Montana: Montana Bur. Mines and Geology Bull. 73, 9 p., illus., tables, 1969.

An area of approximately 220 square miles in Custer and Powder River Counties was mapped. The Tongue River Member of the Fort Union Formation here contains strippable coal in three beds, the Knoblock, the Flowers-Goodale, and the Terret. Strippable reserves in beds at least six feet thick and covered by no more than 120 feet of overburden are estimated at 1.2 billion tons. The low-sulfur low-ash fuel has a rank of lignite or subbituminous coal. —Authors' abstract

Glaister, R. P. *See* Maiklem, W. R. 04833

04389 **Gold, D. P.** Diatremes in the Montreal-Oka area [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 134, 1969.

04390 **Gold, D. P.** The Oka carbonatite and alkaline complex [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 134-135, 1969.

Gold, D. P. *See* Deines, P. 04395

04842 **Goles, G. G.** Cosmic abundances, Chap. 5 *in* Handbook of geochemistry, V. 1 (K. H. Wedepohl, editor): Berlin and New York, Springer-Verlag, p. 116-133, tables, 1969.

The problems and parameters for defining solar system abundances are discussed, with brief reference to the significance of the so-called cosmic abundance curve for estimation of the bulk composition of the Earth and definition of the origin of elements. The data indicate large-scale Fe/Si fractionation in the inner solar system and loss of volatile elements from the Earth, but do not yield conclusive evidence for determining the degree of reduction in the Earth's interior relative to that in meteorites or for identification of the volatile elements. —MS

Goles, Gordon G. *See* Randle, Keith. 04626

04406 **Golightly, J. P.** The birefringence and dichroism of silicon carbide polytypes: Canadian Mineralogist, v. 10, pt. 1, p. 105-108, illus., table, 1969.

The birefringence of 11 synthetic nitrogen-doped silicon carbide polytypes has been measured using an interference fringe method in prisms cut from syntactically intergrown polytypic crystals. Data are tabulated. —VSN

Goodman, R. H. *See* Ommanney, C. S. L. 04504

Goolsby, D. A. *See* Leve, G. W. 04510

04614 **Gordon, G. E.; Dran, J. C.; Baedecker, P. A.; Anderson, C. F. L.** Extensions of the use of Ge(Li) detectors in instrumental neutron activation analysis of geological samples, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 399-403, illus., table, 1969.

The use of Ge(Li) detectors in instrumental neutron activation analysis is extended to very short-lived species and to classes of geologic samples not considered in an earlier study (1968). Within three minutes after irradiation taking of gamma-ray spectra of sample and monitoring with a 30 cm^3 Ge(Li) detector and 4096 channel analyzer was started. Spectra taken within a few minutes after irradiation are in general dominated by 2.3 min Al-28; abundances are sufficiently small, however, in ultramafic rocks and stony meteorites that gamma rays from 3.8 min V-52 and 9.5 min Mg-27 can be observed. Concentrations of the three elements can be determined by comparison of photopeak areas with those of the monitor solution. Preliminary results are listed for USGS standard samples PCC-1, DTS-1 and seven stony meteorite samples. —VSN

Gormsen, K. *See* Bridgwater, D. 04977

04663 **Gorsline, Donn S.** Sedentary [!Sedimentary] processes and their role in the formation of future source and reservoir rocks [abs.]: Tulsa Geol. Soc. Digest, v. 36, p. 91-92, 1968 [1969].

04453 **Gott, Garland B.; McCarthy, J. Howard, Jr.; VanSickle, Gordon H.; McHugh, John B.** Distribution of gold and other metals in the Cripple Creek district, Colorado: U.S. Geol. Survey Prof. Paper 625-A, p. A1-A17, illus., tables, 1969.

Analyses of surface samples from rocks throughout the Cripple Creek district show that several extensive gold-silver-tellurium anomalies exist. These anomalies are coextensive or partly coextensive with anomalies of iron, lanthanum, lead, mercury, antimony, arsenic, and vanadium. Manganese seems to be most concentrated in a zone peripheral to the highest gold concentrations. Hydrothermal alteration has resulted in the replacement of sodium in the sodium-rich minerals by potassium. The highest concentrations of gold, silver, tellurium, and iron conform well with the areas of greatest potassic alteration. In general, the abundance of the metals is in inverse proportion to their abundance in the Earth's crust. The largest gold anomalies are suggested as exploration targets for large low-grade gold deposits. —GBG

Gott, Garland B. *See* McCarthy, J. H., Jr. 04955

Gottfried, David. *See* Tilling, Robert I. 04441

04695 **Gough, D. I.** Incremental stress under a two-dimensional artificial lake: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1067-1075, illus., 1969.

Seismic activity has been induced by loading and possibly lubrication of faults in rocks underlying several artificial lakes. Such evidence of failure justifies study of incremental stress distributions produced by the filling of artificial lakes. In this paper two-dimensional lakes are considered. Equations are derived giving the incremental stress components due to a side of a water-filled trough of polygonal section in the surface of an elastic half-space. A computer program based on these equations is described. Distributions of stress parameters are shown for lakes of rectangular and isosceles triangular sections, and for a two-dimensional approximation of a section of the lake forming behind the Bennett Dam on the Peace River, British Columbia. —Author's abstract

Gower, J. A. *See* Drummond, A. D. 04364

04419 **Graham, A. R.** Quantitative determination of hexagonal and monoclinic pyrrhotites by X-ray diffraction: Canadian Mineralogist, v. 10, pt. 1, p. 4-24, illus., tables, 1969.

Measurement of difference in amplitude of components at about 51.75° and 51.40°2θ (Co Kα radiation) of the asymmetric X-ray diffraction peak resulting from partial superposition of strong diffractions from corresponding planes in hexagonal and monoclinic pyrrhotite structures allows rapid quantitative determination of amounts and proportions of these structures in certain sulfide ores carrying at least 3 percent of either pyrrhotite type. The differences in amplitudes from synthetic mixtures of the pure structures are divided by amplitudes of a nearby diffraction peak from an internal standard added in constant proportion; resulting ratios are plotted against known proportions of either structure. The plot may be checked against weights of magnetic concentrates of monoclinic pyrrhotites from ores under study. —*from* Author's abstract

Grasty, R. L. *See* Gandhi, S. S. 04717

Graterol, M. *See* Naldrett, A. J. 04378

04791 **Graves, Roy W.; Helander, Donald P.; Martinez, S. J.** The University of Tulsa information retrieval system: Geoscience Inf. Soc. Proc., v. 1, p. 18-26, illus., 1969.

Petroleum Abstracts reviews all phases of petroleum exploration and production on a weekly basis. Each abstract is indexed according to key words that are listed in a thesaurus. The bibliographic citations and key index terms are entered on magnetic tape as an information storage file. This file is used to produce the Alphabetic Subject Index each month, the Dual Dictionary Coordinate Index every four months, and the cumulative Master Record Tape each year. —Authors' abstract

Graves, Roy W., Jr. *See* Akin, Ralph H., Jr. 04811

04683 **Gray, N. H.; Crain, I. K.** Crystal settling in sills—A model for suspension settling: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1211-1216, illus., 1969.

A quantitative model which takes into account the temperature dependence of magma viscosity is developed to describe the distribution of cumulate crystals in a sill after its solidification, and is compared with natural examples. A precise comparison is not possible as data on the size-distribution and concentration of the cumulate crystals are not available. However, a preliminary analysis suggests that although several major features can be explained the simple model of crystal settling cannot account for the details of the olivine distribution in the Palisades sill and the Uwekahuna laccolith.—Authors' abstract

Green, J. C. *See* Sims, P. K. 04850

04889 **Greer, David M.; Moorhouse, Douglas C.** Engineering-geologic studies for sewer projects—Closure [to 1968 discussion by P. F. Keim, of paper 5780, 1968]: Am. Soc. Civil Engineers Proc., v. 95, Jour. Sanitary Eng. Div., no. SA3, p. 665-666, 1969.

Keim (ibid., v. 94, no, SA4, p. 760-761, 1968) is correct in that an engineering-geologic study, for any project, should not be planned, accomplished, or reported by a "soil mechanicist" who, not understanding engineering problems and costs, could give bad advice. The soil engineer or geologist who reports on a subsurface investigation for a project has the duty and must have the capacity to appraise and report on the significance of his data to the project. As engineers we agree there are not any "standards of the profession", an expression used in court decisions; engineers are held liable for not only their own mistakes, but also for those who use their work. The engineering-geologic study should identify possible and relevant influences, where unit price for items in design should be considered in contract documents. [Original paper, ibid., v. 94, no. SA1, p. 21-30, 1968.] —GDC

Grieve, R. A. F. *See* Gandhi, S. S. 04717

04593 **Griffin, W. L.; Morey, G. B.** The geology of the Isaac Lake quadrangle, St. Louis County, Minnesota: Minnesota Geol. Survey Spec. Pub. Ser. SP-8, 57 p., illus., tables, geol. map, 1969.

The map-area lies between the Mesabi and Vermilion ranges. Lower Precambrian Vermilion rocks which underlie two-thirds of the quadrangle were folded and intruded by the Giants Range Granite during the Algoman orogeny. The middle Precambrian Animikie Group of the Mesabi unconformably overlying the Giants Range Granite in the southeastern corner consists of three sedimentary formations, intruded by gabbro dikes, and metamorphosed by the middle Keweenawan Duluth Complex. The overlying highly metamorphosed rocks have been informally divided into two units: Argo gneiss is the metamorphic equivalent of greenschist facies slate and graywackes to the northwest; Giants Range Granite underlies the southern half and the northeastern corner of the quadrangle. Two major transcurrent faults strike northeastward; evidence suggests that both were active before and after emplacement of the granite.—ESL

04594 **Grimaldi, F. S.; Schnepfe, Marian M.** Mode of occurrence of platinum, palladium, and rhodium in chromitite, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof Paper 650-C, p. C149-C151, illus., 1969.

The fraction of total chromite decomposed by fusion with a deficiency of sodium peroxide is compared to the fraction of total platinum, palladium, or rhodium dissolved. From such data it is inferred that in the chromitite in the Stillwater Complex rhodium occurs almost entirely within, palladium almost entirely outside, and platinum both inside and outside the chromite lattice. —Authors' abstract

04598 **Grommé, C. S.; Wright, T. L.; Peck, D. L.** Magnetic properties and oxidation of iron-titanium oxide minerals in Alae and Makuopuhi lava lakes, Hawaii: Jour. Geophys. Research, v. 74, no. 22, p. 5277-5293, illus., 1969.

Measurement of strong-field magnetization over the temperature range of -196° to 700°C were made on 48 drill core samples of tholeiitic basalt (obtained at temperatures of 50° to 1020°C) from the Alae and Makuopuhi lava lakes on Kilauea. An increase in Curie temperature is found which is due to oxidation of original titanomagnetite to titanium-poor titanomagnetite containing ilmenite lamellas. It is concluded that in some basaltic lavas the magnetic minerals may form through subsolidus reactions at temperatures well below their final Curie temperatures. In such lavas the natural remanent magnetization is a mixture of thermoremanent and high-temperature chemical remanent magnetization. —DBV

04939 **Guilday, J. E.; Hamilton, H. W.; McCrady, A. D.** The Pleistocene vertebrate fauna of Robinson Cave, Overton County, Tennessee [with French and German abs.]: Palaeovertebrata, v. 2, pt. 2, p. 25-75, illus., tables, 1969.

A fauna of 60 vertebrate and 12 invertebrate species is described from a cave deposit; fluorine dates on bones suggest a long period of accumulation. The 48 species of mammals are represented by at least 2,483 individuals, mostly bats and woodrats; but about 15 percent (87 percent of the species) were trapped or were victims of predation (many shrews and small rodents). All of the birds, reptiles, amphibians, and snails, and 26 mammal species live in the area today; six live only as boreal relicts in the mountains of eastern Tennessee; 10 no longer live as far south; the six extinct forms—*Canis dirus, Ursus americanus amplidens, Sangamona furtiva, Dasypus bellus, Mammut americanus, Megalonyx jeffersoni*—suggest a cold-temperate climate associated with late Wisconsin glaciation. —VMJ

04391 **Gunn, B. M.; Duquette, G.** Geochemistry of the Chibougamau metavolcanics, Quebec [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 135, 1969.

04662 **Gupta, Sujoy.** Palynology of the upper Strawn Series (Upper Pennsylvanian) of Texas above the *Fusulina* Zone: Palaeontographica, Abt. B, v. 125, nos. 4-6, p. 150-196, illus., 1969.

The association of key miospore genera and species of the East Mountain Shale (upper Strawn Series) above the *Fusulina* Zone positively indicates the late Westphalian D age (Cygnian Stage of the Des Moines Series). The assemblage is equivalent to the Spore Division VBI of eastern Canada, Zone S4 of England and Wales, and Zone 11B of the Saar basin, Germany. The strata in question are younger than the Danville Coal, and older than the Trivoli Cyclothem deposits of Illinois. Among one hundred and ten species reported here, thirty were new. —Author's abstract

04505 **Gupta, Y. P.; Santhanam, A. T.** On cleavage surface energy of calcite crystals [with French and German abs.]: Acta Metallurgica, v. 17, no. 4, p. 419-424, illus., table, 1969.

By use of the modified Gilman cleavage technique, the true surface energy of [$10\bar{1}1$] planes of calcite at 298°K and at widely different strain rates (0.02 and 1.0 in/min) as well as at 77°K and at 0.02 in/min was determined. The data are analyzed in terms of a new parameter "Reciprocal Apparent Surface Energy" and its variation with crack length and crystal dimensions. The results indicate that the temperature and the strain rates employed do not have an appreciable effect on the experimental cleavage surface energy of calcite. Experiments at 298°K on calcite crystals with trace impurities of Fe, Cu, and S, indicated that the cleavage surface energy of calcite increased by about three times due to the presence of these impurities. —Authors' abstract

Guy, H. P. *See* Rathbun, R. E. 04670

04644 **Hadley, Donald Gene.** The sedimentology of the Huronian Lorrain Formation, Ontario and Quebec, Canada [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 256B, 1969.

04886 **Hadley, Richard F.** (chairman, Work Group). Decade representative and experimental research basins in the United States—A U.S. contribution to the Internat. Hydrological Decade, 1965-74: Denver, Colo., U.S. Natl. Comm. Internat. Hydrol. Decade, Natl. Research Council, 268 p., illus., 1969.

Hydrological research and related studies are being carried out in 60 experimental and representative study areas in 22 states of the United States by a variety of agencies and universities. This report presents results of an inventory of studies in progress in 1968. For each basin the following material is summarized: organization in charge of activity, physiographic province, physiographic description of region, location of basin, physiographic description of basin, equipment, objectives, history and present work, proposed developments, and key publications. Sketch maps presented for each basin are keyed to an explanatory chart. —MCM

Hagegeorge, Charles G. *See* Hill, William T. 04585

04619 **Hale, L. A.** Phosphate exploration using gamma-radiation logs, Dry Valley, Idaho [abs.]: Mining Eng., v. 21, no. 8, p. 35, 1969.

04511 **Hales, A. L.** Gravitational sliding and continental drift: Earth and Planetary Sci. Letters, v. 6, no. 1, p. 31-34, illus., 1969.

A universal low velocity layer in the upper mantle could mean that the rocks are near the melting point and so permit speculation that the movements due to isostatic adjustment and polar wander occur in that zone. The "effective viscosity" of the upper mantle is lowest in the low velocity zone, and flow and yield to long term stresses are more likely to occur there than elsewhere in the mantle. Calculations show that gravity sliding, resulting from irregular topography in the mantle, could result in continental drift.—HRC

Hall, H. T. *See* Yund, R. A. 04570

Haller, William A. *See* Filby, Royston H. 04625

Hamaguchi, H. *See* Higuchi, H. 04624

Hamilton, H. W. *See* Guilday, J. E. 04939

04573 **Hamilton, Stanley K.** Copper mineralization in the upper part of the Copper Harbor Conglomerate at White Pine, Michigan—A reply [to discussions by Ohle (1968) and Brecke (1968) of paper by Hamilton (1967)]: Econ. Geology, v. 64, no. 4, p. 462-464, 1969.

Arguments for a post-diagenetic age for the native copper in sandstone depend on a demonstration that the distribution of native copper, hydrocarbon, and chloritic alteration of the uppermost Copper Harbor Conglomerate are structurally controlled. Evidence for structural control is inconclusive or outweighed by evidence for control by sedimentary features. (For original paper see ibid., v. 62, p. 885-904, 1967; for discussions see E. L. Ohle, ibid., v. 63, p. 190-191, 1968 and E. A. Brecke, ibid., v. 63, p. 294, 1968.) —WSW

04704 **Hammel, D. J.** A mathematical model for pit slope stability, *in* Operations research and computer applications in the mineral industries: Colorado School Mines Quart., v. 64, no. 3, p. 53-69, illus., tables, 1969.

A statistical model was constructed to determine quantitatively the effect, if any, of several selected variables on movement of an unstable slope. The model shows how each variable affects movement of the slope and also is utilized to predict the amount or monthly rate of movement. The final model, which is an equation, contains variables that affect slope movement for conditions present in this unstable slope. —KAF

04496 **Handin, John.** On the Coulomb-Mohr failure criterion: Jour. Geophys. Research, v. 74, no. 22, p. 5343-5348, illus., tables, 1969.

Coulomb's criterion for the shear fracture of a brittle material is that total shearing resistance is the sum of the cohesive shear strength (independent of direction) and the product of the effective normal stress and the coefficient of internal friction (a constant independent of normal stress). Mohr generalized this criterion by extending it to a three-dimensional state of stress, and by allowing for a variable coefficient. The coefficients of internal and external (sliding) friction are not the same in general. Both tend to decrease with increasing normal stress, and their relative magnitudes may determine if failure occurs by new shear fracturing or by slip on pre-existing cohesionless surfaces like joints in rocks. —Author's abstract

04783 **Hanna, G. Dallas.** Diatoms and diatomite: California Div. Mines and Geology Mineral Inf. Service, v. 22, no. 7, p. 111-115, illus., 1969.

Interest in fossil diatoms in California dates back more than a century; by 1928, 171 species had been listed in print. Long after the classification, the economic importance of diatoms began to attract interest, the first uses being as a polishing agent and a carrier for nitroglycerine; insulating properties were soon discovered. Commercial deposits are Tertiary, others vary from Cretaceous to Pleistocene. They also are used as index fossils. Eight photomicrographs obtained by the stereoscan method, and 12 photographs by ordinary light microscope are included. —ESL

04981 **Hansen, Harry J.** Depositional environments of subsurface Potomac Group in southern Maryland: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 1923-1937, illus., table, 1969.

Fluvial-deltaic lithofacies of the Cretaceous Potomac Group were delineated by subsurface data during ground-water studies in the Baltimore-Washington area. The Baltimore area was a locus for fluvial sedimentation of braided or multistory sands on the upper floodplain of a major axial river system during deposition of the Patuxent and Patapsco Formations. Sands in these deposits give coefficients of transmissibility between 25,000 and 75,000 gpd/ft. Southward, lithofacies indicate a floodplain of meandering streams and fringing swamps; aquifer transmissibility values are less than 5,000 to 25,000 gpd/ft. Sand content decreases southward and ocherous interbedded clay to the north becomes more gray or greenish gray southward. Resistivity curves of meandering stream deposits show a sharply defined base overlain by a fining-upward sequence; those from braided stream deposits commonly have a massive profile. —EGS

04565 **Hanshaw, Bruce B.; Back, William.** A geochemical hypothesis for dolomitization by ground water [abs.]: Econ. Geology, v. 64, no. 3, p. 349, 1969.

04549 **Haranczyk, Czeław,** Noncolloidal origin of colloform textures [discussion of paper by E. Roedder, 1968]: Econ. Geology, v. 64, no. 4, p. 466-468, 1969.

The term "hemicolloids" is justified for ores in which an increase in colloid properties is an apparent consequence of decrease in grain size. It may be questioned whether supersaturation is the only important condition for formation of "colloform textures," or whether other factors, such as trace elements in the parent solutions, play a part. Rhythmic pulsation of hydrothermal solutions is considered a more likely cause for microbanding than periodic (annual) dilution by surface waters. (For original paper see ibid., v. 63, no. 5, p. 451-471, 1968.) —WSW

Harington, C. R. *See* McAllister, D. E. 04680

Harris, D. C. *See* Faye, G. H. 04362

Harris, D. C. *See* Petruk, W. 04384

04392 **Harris, D. C.; Cabri, L. J.; Kaiman, S.** A new copper selenide from Martin Lake, Saskatchewan [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 135-136, 1969.

Harris, D. C. *See* Cabri, L. J. 04405

04709 **Harris, D. P.; Zodrow, E. L.** Magnetite trend surface analysis—A guide for open pit quality production control at the Smallwood Mine, Newfoundland, *in* Operations research and computer applications in the mineral industries: Colorado School Mines Quart., v. 64, no. 3, p. 203-216, illus., 1969.

Complex geologic and mineralogic relationships in the ore body of the Smallwood Mine, Newfoundland, cause excessive error in grading of magnetite by methods of simple weighted averages. Trend surface analysis assists the grading of magnetite by expressing the interrelationship of the geologic and statistical characteristics of the ore body. —*from* Authors' abstract

04703 **Harris, DeVerle P.** Alaska's base and precious metals' resources—A probabilistic regional appraisal, *in* Operations research and computer applications in the mineral industries: Colorado School Mines Quart., v. 64, no. 3, p. 295-328, illus., tables, 1969.

Three cells (units of the study area) near Fairbanks and two in southeastern Alaska have a residual expected gross mineral wealth of base and precious metal resources of at least 400 million dollars. There are 16 cells with expected residual value between 100 and 400 million dollars and 25 cells between 10 and 100 million dollars. These expected residual values are based on a probability distribution for each cell that resulted from combining probabilities computed by two separate discriminant and classification analyses. —*from* Authors' summary

04705 **Harris, DeVerle P.; Euresty, David.** A preliminary model for the economic appraisal of regional resources and exploration based upon geostatistical analysis and computer simulation, *in* Operations research and computer applications in the mineral industries: Colorado School Mines Quart., v. 64, no. 3, p. 71-98, illus., 1969.

It is proposed that a cell (subdivision of a study area) with less favorable geology but favorably located relative to existing markets and transportation may at a given point in time constitute a more profitable area for exploration than one not so favorably situated but having more promising geology. Multivariate geostatistical analysis and computer simulation are used to analyze simultaneously the probabilistic events and economic and physical conditions. —KAF

04564 **Harris, Leonard D.** A lower Paleozoic paleoaquifer—The Kingsport Formation and Mascot Dolomite of Tennessee [abs.]: Econ. Geology, v. 64, no. 3, p. 349, 1969.

04493 **Harris, Stuart A.** Isostatic recovery near glacier-ice margins—Some evidence from Waterloo, Ontario, Canada [with French abs.], *in* The periglacial environment, past and present (T. L. Péwé, editor)—Internat. Assoc. Quaternary Research, 7th Cong., Alaska, 1965: Montreal, Quebec, McGill-Queen's Univ. Press, p. 271-283, illus., table, 1969.

During the Late Wisconsin ice retreat, a minor readvance produced a series of lakes, which resulted in overflow channels and erosional terraces. The highest terrace has isobases trending at 108° east of north, and inclined 22 ft/mi to the south. The directions changed to 92° east of north and 8 ft/mi as the ice melted. Decrease of tilt continued until the end of the retreat phase. Isostatic changes then occurred, and all seem to have been rapid, their magnitude suggesting that movements follow the Airy-Heiskanen theory. The effect of these movements is probably superimposed on the effect of the movements suggested in the Vening-Meinesz theory. These results agree with the evidence of isostatic movements from the other sources. —*from* Author's abstract

Harrison, Christopher G. A. *See* Emiliani, Cesare. 04777

Harrison, Stanley C. *See* Jacka, Alonzo D. 04482

Hart, S. R. *See* Brooks, C. 04340

Hart, S. R. *See* Brooks, C. 04341

04792 **Harvey, Anthony P.** Recent developments in geological documentation and bibliography: Geoscience Inf. Soc. Proc., v. 1, p. 27-53, 1969.

This review of documentation and bibliography of earth sciences does not attempt to be complete, as about 300 bibliographies have been recorded in the last three years. Developments are grouped into: arrangement by type of publication, bibliographies and documentation in individual facets of the earth sciences, and an annotated list of all material mentioned in the body of the text. No attempt has been made to cover the general reference and bibliographic aids that have been published in the last four years although many of these will be of considerable use to the earth scientist. —MCM

04597 **Hatherton, Trevor; Dickinson, William R.** The relationship between andesitic volcanism and seismicity in Indonesia, the Lesser Antilles, and other island arcs: Jour. Geophys. Research, v. 74, no. 22, p. 5301-5310, illus., table, 1969.

The relationship between K, the level of potash content in lavas erupted from an andesite volcano, and h, the depth to the center of the inclined seismic (Benioff) zone beneath the volcano, is extended using new data from Indonesia, the Lesser Antilles, and New Zealand. Coefficients of correlation between K and h of + 0.86 (K_{35}) and + 0.80 (K_{60}) are obtained by straight-line regression. This is compared with a coefficient between K_{35} and distance d of the volcano from the trench of only + 0.60. The coefficients of correlation of K against h_{min}, which is the depth to the *upper* surface of the Benioff zone, are not significantly different from those between K and h. —Authors' abstract

Hattin, Donald E. *See* Kauffman, Erle G. 04961

04995 **Hawley, John; Kottlowski, Frank E.; Seager, William R.; King, William E.; Strain, William S.; LeMone, David V.** The Santa Fe group in the south-central New Mexico border region, *in* Border stratigraphy symposium—AAAS S.W. and Rocky Mtn. Div., 44th Ann. Mtg., El Paso, Tex., 1968: New Mexico Bur. Mines and Mineral Resources Circ. 104, p. 52-76, illus., 1969.

The group is a complex sequence of piedmont-slope alluvium, playa, lacustrine, and fluvial deposits, and some basaltic volcanics within and adjacent to the Rio Grande depression. Paleontology, K-Ar dating of the basalt, and ash-lens correlations have established a Miocene to mid-Pleistocene age for the intermontane basin filling in the

border region. Early stages of intermontane basin filling occurred in closed-basin environment, while later stages were marked by coalescence of basin floors and development of a regional system of through-drainage. Thus, Santa Fe Group deposition in the border region corresponds with Bryan's idealized concept of basin filling in the type Santa Fe region to the north. Ground water, sand, gravel, clay, and caliche are mineral resources. —*from* Authors' abstract

04997 **Hawley, John W.; Kottlowski, Frank E.** Quaternary geology of the south-central New Mexico border region, *in* Border stratigraphy symposium—AAAS S.W. and Rocky Mtn. Div., 44th Ann. Mtg., El Paso, Tex., 1968: New Mexico Bur. Mines and Mineral Resources Circ. 104, p. 89-115, illus., tables, 1969.

In early mid-Quaternary time the basins were still internally-drained. In later stages of basin filling, local upland sources were supplemented by the ancestral Rio Grande by early Kansan time. Basin filling in adjacent areas ceased by late Kansan to early Illinoisian time. The Rio Grande Group fills the basins, and the Jornada and La Mesa geomorphic surfaces cap the Santa Fe sequence. Cyclic entrenchment of the Rio Grande began after mid-Pleistocene integration of the lower and upper segments of the ancestral Rio Grande, and four major, climatically controlled cycles of valley cutting have taken place. Some basins continue to aggrade, and some basins were occupied by lakes during Pleistocene pluvials. Deformation and extrusion of basalt and maare formation in the Mesilla bolson represent continuation of deep-seated disturbances in Quaternary time. —*from* Authors' abstract

Heard, H. C. *See* Borg, I. Y. 04698

04896 **Heckel, Philip H.** Devonian Tully Limestone in Pennsylvania and comparison to type Tully Limestone in New York: Pennsylvania Geol. Survey, 4th ser., Inf. Circ. 60, 33 p., illus., tables, 1969.

In contrast to thick-bedded pure calcilutite dominant in New York, outcropping Tully limestone in central Pennsylvania consists of shaly calcilutite and calcareous shale. The Tully grades eastward in Pennsylvania to noncalcareous shale and extends southward as a tongue of calcareous shale into West Virginia. In west-central Pennsylvania a brachiopod fauna in the Tully base is succeeded upward by a diverse assemblage; this succession correlated with that typical of the lower and upper members in New York. Tully calcilutite contains skeletal material with roughly similar biological composition in both states, although that in Pennsylvania contains a greater admixture of acid-soluble terrigenous mud and is intercalated with more calcareous shale. Because Tully carbonate mud was probably allochthonous, its origin must have been north of the New York outcrop. —*from* Author's abstract

Heezen, Bruce C. *See* Johnson, G. Leonard. 04969

04393 **Heinrich, E. W.; Moore, D. G.** Metasomatic potash feldspar rocks associated with alkalic igneous complexes [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 136, 1969.

Helander, Donald P. *See* Graves, Roy W. 04791

04876 **Henderson, G.** Field work supplementing photogeological interpretation of Nûgssuaq, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 18-21, 1969.

The Itivdle Valley marks a fault zone trending NE-SE, with fault contacts along the northwestern side between Cretaceous-Tertiary rocks and picritic, olivine-rich basalts, and between these basalts and plagioclase-porphyritic basalts. The fault pattern is very complex. The main ones are downthrown to the northwest, but within the block-faulted area are faults with a variety of directions; some are antithetic. The area east of Itivdle is much simpler structurally; one normal fault, with a displacement of several hundred meters runs SE-NW. West of this is a gentle syncline. Much of the volcanic sequence begins with subaqueous deposits, herein called pillow breccia. Other features are described briefly. —HRC

04978 **Henriksen, Niels.** Field mapping in the inner part of the Scoresby Sund area, East Greenland, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 50-53, 1969.

The results of the mapping confirm generally the main geological results of previous workers. However, it is preferred to regard the two cover sequences as independent, and there is no real evidence that they are Caledonian in age. These two supracrustal sequences, locally associated with synkinematic granites, overlie an old gneissic basement (partly reactivated). An extensive migmatized region and some late postkinematic granites are also present. —HRC

04942 **Herman, Yvonne; Rosenberg, P. E.** Pteropods as bathymetric indicators: Marine Geology, v. 7, no. 2, p. 169-173, illus., table, 1969.

Pteropods are believed to have great potential as bathymetric indicators due to the restricted depth ranges of certain species and to rapid settling velocities which should lead to deposition close to their habitat. In accord with this hypothesis, the *Creseis* spp./*Limacina inflata* ratio has been found to be depth-dependent in sediments from the open shelf off western India; the ratio being high in shallow water (<100 m) and decreasing rapidly with increasing depth. —Authors' abstract

04928 **Herzenberg, C. L; Riley, D. L.** Interpretation of the Mössbauer spectra of marine iron-manganese nodules: Nature, v. 224, no. 5216, p. 259-260, 1969.

Attention is drawn to the similarity between the Mössbauer spectrums of manganese nodules and the spectrums of the iron oxide-hydrate gels reported by Van der Giessen (1967, 1968) and of the hydrated ferric oxide polymers discussed by Brady and others (1968). Consideration of the possibility of the presence of similar hydrate ferric oxide polymer material is not only more consistent with other data on the composition of manganese nodules, but also permits a more satisfactory detailed interpretation of their Mössbauer spectrums. — DBV

Hetherington, E. A., Jr. *See* Denison, Rodger E. 04988

Hetland, D. L. *See* Sharp, B. J. 04620

04706 **Hiatt, Jerry K.** Mineralization pattern prediction and ore deposit evaluation, *in* Operations research and computer applications in the mineral industries: Colorado School Mines Quart., v. 64, no. 3, p. 99-106, illus., 1969.

Ore deposit evaluation methods described in this paper require construction of mathematical models which approximate patterns inferred from assay and other exploration data. Patterns describing physical characteristics and gradational trends within a deposit are determined by evaluating residual effects of factors which influenced mineral concentration and deposition. Computer programs have been written which establish a statistical reliability envelope for model specifications, perform mathematical operations necessary for model construction, and present a visual display of resultant models. —*from* Author's abstract

04624 **Higuchi, H.; Tomura, K.; Takahashi, H.; Onuma, N.; Hamaguchi, H.** Use of a Ge(Li) detector after simple chemical group separation in the activation analysis of rock samples—[Pt.] 4, Simultaneous determination of strontium and barium, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 334-338, table, 1969.

Rapid simultaneous analysis is reported of strontium and barium in standard rock samples using a Ge(Li) detector after short sample neutron irradiation. Results are tabulated for standard samples G-1, W-1, G-2, GSP-1, AGV-1, BCR-1 and compared with analyses by other methods. Determinations are attainable for both elements to the lower detection limit, Sr 10 ppm, Ba 5 ppm. —VSN

04562 **Hill, William T.; Wedow, Helmuth, Jr.** Porosity and permeability of Lower Ordovician carbonate rocks in East Tennessee during early Middle Ordovician time [abs.]: Econ. Geology, v. 64, no. 3, p. 350-351, 1969.

04585 **Hill, William T.; Morris, Raymond G.; Hagegeorge, Charles G.** Ore controls and related features at the Flat Gap Mine, Treadway, Tennessee [abs.]: Econ. Geology, v. 64, no. 3, p. 350, 1969.

Hills, L. V. *See* Vagvolgyi, A. 04821

04432 **Hintze, L. F.; Braithwaite, L. F.; Clark, D. L.; Ethington, R. L.; Flower, R. H.** A fossiliferous Lower Ordovician reference section from western United States, *in* The Ordovician symposium—El Paso Geol. Soc., 3d Ann. Field Trip, 1969: El Paso, Tex., El Paso Geol. Soc., p. 8-30, illus., 1969.

The lower Ordovician stratigraphy and paleontology of the Ibex area southwest of Delta, Utah is described. Ordovician strata in the Ibex area are almost undeformed and are exposed in Cenozoic normal faults. Ibex Ordovician rocks are assigned to the Pogonip Group (more than 1,000 m thick in this area) which is subdivided into the House Limestone, Fillmore Limestone, Wahwah Limestone, Juab Limestone, Kanosh Shale, and Lehman Formation. Characteristic fauna is described. —KAF

04546 **Hoagland, Alan D.** Appalachian strata-bound deposits; their essential features, genesis, and the exploration problem [abs.]: Econ. Geology, v. 64, no. 3, p. 351, 1969.

04589 **Hodgson, G. W.; Baker, B. L.** Porphyrins in meteorites—Metal complexes in Orgueil, Cold Bokkeveld, and Mokoia carbonaceous chondrites: Geochim. et Cosmochim. Acta, v. 33, no. 8, p. 943-958, illus., tables, 1969.

Porphyrin metal complexes were found to be present in samples of the Orgueil, Murray, Cold Bokkeveld, and Mokoia carbonaceous chondrites. No evidence for similar pigments was found for samples of Vigarano, Indarch, Peace River, and Bruderheim meteorites. Extensive evaluations were made of the possibilities of contamination for the origin of the meteorite pigments involving terrestrial soils, dust, and microorganisms, but no such contamination was found. Since the specific biogenic attributes previously assigned to extraterrestrial porphyrins can no longer be accepted, the meteorite porphyrins may be interpreted as representing either prebiotic chemical evolution, or forms of life or diagenesis appreciably different from those responsible for terrestrial porphyrins. —GV

04434 **Hoffer, Jerry M.** Post Cambro-Ordovician Granite(,) in the Franklin Mountains, El Paso, Texas, *in* The Ordovician symposium—El Paso Geol. Soc., 3d Ann. Field Trip, 1969: El Paso, Tex., El Paso Geol. Soc., p. 102-103, 1969.

On the east side of the Franklin Mountains near El Paso, Texas, directly below "A-Mountain", granite is found in direct contact with the Bliss Sandstone of Cambro-Ordovician age. Thin sections of the granite and sandstone along the contact indicate that the underlying granite is intrusive. —KAF

04998 **Hoffer, Jerry M.** Preliminary note on the Black Mountain basalts of the Potrillo field, south-central New Mexico, *in* Border stratigraphy symposium—AAAS S.W. and Rocky Mtn. Div., 44th Ann. Mtg., El Paso, Tex., 1968: New Mexico Bur. Mines and Mineral Resources Circ. 104, p. 116-121, illus., 1969.

The Black Mountain area consists of about eight cinder and spatter cones associated with six successive intervals of alkaline olivine basalt extrusion. The individual basalt flows are porphyritic and can be differentiated on the basis of the phenocrysts, which consist of plagioclase feldspar, clinopyroxene, and olivine. —Author's abstract

04676 **Hofmann, H. J.; Jackson, G. D.** Precambrian (Aphebian) microfossils from Belcher Islands, Hudson Bay: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1137-1144, illus., 1969.

A small assemblage of primitive microscopic fossils is here reported for the first time from the lower part of the Belcher Group in Hudson Bay. The microbiota includes chains and clumps of bacteria, and filamentous and spheroidal structures of probable algal or fungal affinities. In addition, a variety of isolated and clustered spheroids and

other structures of probable biologic origin is present. The structures are more than 1600 m.y. old, and occur in a black chert associated with thick dolomite beds considered to be of Aphebian (early Proterozoic) age. Morphologically comparable Precambrian microfossils occur in the Gunflint Formation (early Proterozoic, Ontario) and the Bitter Springs Formation (late Proterozoic, central Australia.)—Authors' abstract

04369 **Hogarth, D. D.** Alkali-amphiboles from near Meach Lake, Quebec [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 136, 1969.

04387 **Hogarth, D. D.; Miles, N.** Wakefieldite, natural YVO_4 [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 136-137, 1969.

Hogarth, D. D. *See* Faye, G. H. 04420

Holland, Heinrich D. *See* Raymahashay, Bikash C. 04554

04725 **Holtan, H. N.** Hydrologic research for watershed engineering: Jour. Hydrology, v. 8, no. 2, p. 207-216, 1969.

Watershed engineering is dynamically increasing its scope and vitality in order to integrate a complexity of interests in land and water resources. Agriculture, industry and urban interests vie for the choicest land areas, often with contrasting objectives that can be made compatible only through basin planning. This article is written to inspire objective thinking in the selection of watersheds for research and in the design of the research model. Both stochastic and deterministic approaches are needed but they require different types of research watersheds and, most definitely, different research models. Hopes lie not in the immediate discovery of ultimate solutions, but in providing versatility to meet whatever the future demands. —*from* Author's abstract

Hopkins, David M. *See* Scholl, David W. 04690

04829 **Hornberger, G. M.; Renson, Irwin; Fungaroli, A. A.** Numeric studies of a composite soil moisture ground-water system: Water Resources Research, v. 5, no. 4, p. 797-802, illus., table, 1969.

A model of transient moisture movement in a composite soil moisture ground-water system is described. The model was used to study two-dimensional flow in response to a falling water table. The solution provided information about the interaction of the saturated and unsaturated portions of the subsurface system. The results of the composite model are compared with those obtained from three one-dimensional ground-water models. That soil moisture and nonlinearity do not have a significant effect on the position of the water table in the system studied is inferred. —Authors' abstract

04645 **Horne, John Corbett.** Detailed correlation and environmental study of some Late Pennsylvanian units of the Illinois Basin [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 256B-257B, 1969.

Hoskin, Charles M. *See* Forbes, Robert B. 04857

04388 **Hounslow, A. W.; Chao, G. Y.** The crystal structure of two hexagonal chlorapatite [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 137, 1969.

05011 **Howard, James D.** Depositional control of Upper Cretaceous coal units, *in* Raton basin field trip, Colorado and New Mexico, 1969, Guidebook: Mtn. Geologist, v. 6, no. 3, p. 143-146, illus., 1969.

Two principal depositional features control the location and extent of many coal units in the Upper Cretaceous stratigraphic sequence of the Western Interior. These are: (1) the position and trend of barrier island sand bodies, which mark the landward and seaward extent of the coal units; and (2) the location and nature of chan-

nel-fill deposits, which cut through the coal lagoons and the barrier islands. Both of these features can be located and mapped when outcrop data is combined with core hole logs and mine maps. Failure to recognize the depositional setting of the coal units and their lateral equivalents can lead to unnecessary expense and can contribute added risk to mining personnel.—Author's abstract

04726 **Hrabar, S. V.; Potter, Paul Edwin.** Lower West Baden (Mississippian) sandstone body of Owen and Greene Counties, Indiana: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 10, pt. 1, p. 2150-2160, illus., tables, 1969.

The elongate sandstone body that crops out in Owen and Greene Counties consists of the Bethel and Sample Formations overlain by the Elwren Formation; limestone units which normally intervene are absent. The body is an abandoned distributary finger of the late Paleozoic Michigan River system, and is composed of a lower thin part, probably of tidal origin, and an upper, thicker part. Relationships of high permeability to crossbedding and low permeability to ripple-bedding define reservoir units. Permeability values of sandstones near the surface are much higher than those in the subsurface, the result of decementation by downward-flowing ground water. This suggests how permeability in a sandstone body buried below an unconformity might develop. —EGS

Huang, Jinn Huie. *See* Sherwood, W. Cullen. 04691

04973 **Hughes, O. L.; Campbell, R. B.; Muller, J. E.; Wheeler, J. O.** Glacial limits and flow patterns, Yukon Territory, south of 65 degrees north latitude: Canada Geol Survey Paper 68-34, 9 p., illus., 1969.

This report assembles and correlates evidence of successive advances of Cordilleran ice sheets in the Yukon interior, and of valley glaciers in adjacent mountains. Limits of a late Wisconsin advance are marked by moraines and other ice-marginal features; features of a more extensive, early Wisconsin advance are relatively subdued but distinguishable over much of the area. One or more older and more extensive advances are evident from glacial deposits lacking distinctive geomorphic form. Flow patterns indicate that during the late (McConnell) advance, the ice sheet moved as two more or less distinct lobes—a N and NW flowing Cassiar lobe, and a NW and W flowing Selwyn lobe. Valley glaciers emanating from St. Elias, and from Wernecke and eastern Ogilvie Mts. merged with the two lobes, respectively, whereas valley glaciers of western Ogilvie Mts. remained independent. —*from* Authors' abstract

04370 **Hunt, G. H.** Petrographic and stratigraphic studies of the Precambrian in the Iskwasum Lake area of northern Manitoba [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 137, 1969.

04813 **Hyndman, D. W.** Geology, Nakusp, Kootenay District, British Columbia: Canada Geol. Survey Map 1234A (*also in* Bull. 161), scale 1:63,360, sections, 1969.

04966 **Hyndman, D. W.** Petrology and structure of Nakusp map-area, British Columbia [with French abs.]: Canada Geol. Survey Bull. 161, 95 p., illus., tables, geol. map, 1968 [1969].

Field descriptions, mineralogy, and petrography are given for the high- to low-grade metamorphic rocks of this area. A map showing distribution of five metamorphic facies and subfacies corresponding to five grades of progressive regional metamorphism is included; a single culminating episode of regional metamorphism is suggested. Superimposed contact metamorphism has been distinguished where granitic stocks have intruded low-grade country rock. The granitic plutons are concordant and elongate parallel to structure; alkalic and calc-alkalic intrusive rocks, present also, are described. Three problems raised by feldspars of the granitic rock are: magmatic or postmagmatic origin of megacrysts; magmatic crystallization or exsolution origin of albite leucogranites of the Kuskanax type, and the relation of orthoclase to microcline in rocks containing both. —ESL

04892 **Iben, Icko.** Comprehensive information retrieval in the field of water resources: Water Resources Bull., v. 5, no. 2, p. 51-58, 1969.

The ages-old and ever-growing need for communication and information retrieval among scientists has found expression in the development of indexes, abstracts, reviews and combinations or variations of such. A short review of such efforts is followed by a discussion of efforts along these lines in the new field of water resources science and technology. Such undertakings as the Information Retrieval System of the American Society of Civil Engineers and of the U.S. Water Resources Research Office are compared with that of the American Water Resources Association. —Author's abstract

04905 **Ibers, James A.** Scaling of diffractometer data affected severely and variably by crystal decomposition: Acta Cryst., v. B25, pt. 8, p. 1667-1668, illus., 1969.

The scale factor for a given data set is written as a power series in t_n where t_n is the cumulative X-ray exposure of the crystal at the time the nth observation is made. The coefficients in this power series are determined, along with the structural parameters, by the usual least-squares refinement procedure. The advantage of this method of scaling the data is that it is based on all of the observations, rather than on the changes in intensity of a few, possibly atypical, check reflections. The method has been found to be effective and practical, and is especially suitable when there is appreciable and variable decomposition of the crystal in the X-ray beam. —Author's abstract

04484 **Ireland, Herbert O.** Foundations for heavy structures, *in* Reviews in engineering geology, V. 2 (D. J. Varnes and George Kiersch, editors): Boulder, Colo., Geol. Soc. America, p. 1-15, 1969.

The choice of foundation types and structural material to be used depends upon the type of structure, the loads it must carry, the subsurface conditions and the cost relative to the superstructure. Design of the foundation should be evaluated with respect to such factors as bearing capacity, and settlement, possible seasonal volume changes of the subsoil, scour if the soil is subject to running water, and uplift of lateral forces. Improvement of the subsoil may sometimes be achieved by appropriate treatment, such as increasing the density by driving piles or by vibroflotation, promoting rapid consolidation through sand drains, or stabilizing by chemical or thermal means. —*from* Author's abstract

04989 **Iturralde-Vinent, Manuel A.** Principal characteristics of Cuban Neogene stratigraphy: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 1938-1955, illus., table, 1969.

Neogene rocks of Cuba are divided into five lithofacies complexes, principally Miocene: Complex I, Pinar del Rio Province—carbonate, sandstone-shale, and conglomerate shallow water; Complex II, Habana and Matanzas Provinces—largely deep-water marl, shale, limestone, and local neritic sandstone and limestone; Complex III, southern Isle of Pines—shallow neritic carbonate sequence; Complex IV, Las Villas, Camaguey, western Oriente—mostly carbonates and terrigenous clastics of shallow neritic deposition; Complex V, rest of Oriente Province—conglomerate, sandstone, shale, marl, limestone, and dolomite beds deposited in diverse environments. The rocks are transgressive cover deposits, transgressive-regressive strata of subsiding deep basins, and transgressive deposits of shallow neritic basins. Shallowing of the sea from Miocene through Pliocene, and emergence is indicated. —*from* Author's abstract

Ives, Jack D. *See* Bryson, Reid A. 04825

04482 **Jacka, Alonzo D.; Thomas, Carroll M.; Beck, Ray H.; Williams, Karl W.; Harrison, Stanley C.** Guadalupian depositional cycles of the Delaware Basin and Northwest Shelf, *in* Cyclic sedimentation in the Permian Basin—Symposium, Midland, Tex., 1967: West Texas Geol. Soc. Pub. 69-56, p. 152-196, illus., 1969.

The following depositional environments can be distinguished in Delaware Mountain Group exposures: (1) submarine canyon "fill", (2) proximal fan, (3) intermediate fan, (4) distal fan, and (5) fringe. Numerous cycles of expansion and constriction of shelf lagoons controlled sediment economics of both basin and shelf. —KAF

Jackson, Dallas B. *See* Zohdy, Adel A. R. 04784

Jackson, G. D. *See* Hofmann, H. J. 04676

Jackson, Stewart A. *See* Billings, Gale K. 04568

04712 **Jam L., Pedro; Dickey, Parke A.; Tryggvason, Eysteinn.** Subsurface temperature in South Louisiana: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 10, pt. 1, p. 2141-2149, illus., tables, 1969.

Many subsurface temperature observations from South Louisiana were obtained from the Federal Power Commission. Most of the measurements were made with calibrated maximum thermometers long after the wells had been completed. Temperature-depth curves could be obtained for 123 fields. The temperature gradients ranged from 18 to 36°C/km of depth; most were between 22 and 24°C/km. At a depth of 3,048 m (10,000 feet) there is a belt of high temperature near the present coastline. This hot belt is located approximately where the sedimentary strata are believed to be of maximum thickness, which is estimated to be about 15,000 m. It is suggested that metamorphicm and recrystallization already have begun in the lowest part of the sedimentary section, and the consequent increased thermal conductivity may account for the high temperatures along the belt of maximum thickness. —*Authors' abstract*

04363 **Jambor, J. L.; Fong, D. G.; Sabina, Ann P.** Dresserite, the new barium analogue of dundasite: Canadian Mineralogist, v. 10, pt. 1, p. 84-89, tables, 1969.

Dresserite occurs with weloganite in cavities in an alkalic sill intruding limestone at St-Michel, Montreal Island, Quebec. Chemical analysis corresponds to $Ba_{1.00}Al_{4.06}C_{4.06}O_{23}H_{12.67}$, ideally $Ba_2Al_4(CO_3)_4(OH)_8{\times}3H_2O$. This is the barium analog of the lead mineral, dundasite. Dresserite occurs as white spherical aggregates averaging about 2 mm in diameter, each of tapering fibers elongated parallel to *c*. It is biaxial negative with 2V = 30° to 40°; extinction is parallel. The mineral is orthohombic a = 9.27, b = 16.83; c = 5.63 A; the space group can be Pbmm, $Pb2_1m$, or Pbm2. The X-ray powder pattern superficially resembles that of dundasite. Strongest pattern lines and a complete listing of observed spectra are given with those of dundasite for comparison. —*from* Authors' abstract

04815 **James, W. R.; Krumbein, W. C.** Frequency distributions of stream link lengths: Jour. Geology, v. 77, no. 5, p. 544-565, illus., tables, 1969.

The population distribution of link lengths has an important relation to the statistical properties of entire networks, and plays a basic role in computer simulation models of stream patterns. Analysis of interior links in a magnitude 1311 basin shows that the probability of successive tributaries entering main channels from the same side is only about two-thirds the probability of opposite-side entry. These higher-order structures in the data display a first-order Markovian property in sequences of link type. These structures are examined and a composite gammalike population density for interior link lengths is developed theoretically. This density contains the higher-order structures and agrees, at least approximately, with observed relations in main channels of magnitude 10 or greater. —*from* Authors' abstract

04724 **Jamieson, D. G.; Amerman, C. R.** Quick-return subsurface flow: Jour. Hydrology, v. 8, no. 2, p. 122-136, illus., table, 1969.

One of the least understood of all hydrologic problems is that of lateral flow in the soil's upper horizons. The nature and quantity involved in this quick-return flow are unknown and have to be inferred from the shape of the observed hydrograph. An attempt has been made to mathematically simulate the flow phenomenon using rainfall as input and a system of interconnected, nonlinear reservoirs as the operator. [A study in the Coshocton, Ohio, area is cited as an example.] —Authors' abstract

04555 **Jansen, G. J.; Sorensen, J. M.; Kearney, R. J.** Ellipsometric determination of optical constants of metals—A contribution to reflectivity standards for ore microscopy: Econ. Geology, v. 64, no. 3, p. 325-328, illus., tables, 1969.

Indices of refraction and absorption coefficients were determined for polished surfaces of silicon, tungsten, nickel, and aluminum by means of extinction measurements in elliptically polarized light. Measurements were made at wavelengths of 4,860, 5,460, 5,890, and 6,200 angstroms. Reflectivities, at normal incidence, were calculated from the indexes of refraction and absorption coefficients. Results on tungsten and nickel were close to reflectivities measured photometrically in another laboratory. Results on silicon differed by a maximum of 3.3 percent of the reflectivities measured photometrically. —Authors' abstract

Jenkins, W. A., Jr. *See* Wermund, E. G. 04518

04865 **Jensen, Stig Bak.** Field work in the Frederikshaab district, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 33-35, 1969.

The hornblende gneisses of the region are better described as "schistose amphibolites". The term "amphibolite" can be used for all types of basic layers and lenses found within the gneisses of the region regardless of the degree of development of foliation. When the amphibolites are more strongly transformed by the gneissification the term "migmatitic amphibolite" is used. The schistose amphibolite horizons can alter to migmatitic amphibolites along the strike. Supracrustal metavolcanic rocks are found in two areas of the region, but their relations to each other are not yet clear. —HRC

04878 **Jepsen, H. F.** Preliminary report on the stratigraphy of the Precambrian and Eocambrian sediments in the Jörgen Brönlund Fjord-Midsommersö area, southern Peary Land, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 11-14, illus., 1969.

The oldest sedimentary rocks are Precambrian sandstones, and they are overlain by Eocambrian(?) clastic and dolomitic rocks, which in turn are overlain by Paleozoic dolomites and limestones. The Precambrian-Eocambrian boundary is placed at the lower boundary of tillite. The rocks are not folded and dip gently at 2°; ENE-WSW-striking block faults are present. The Precambrian rocks are at least 420 m thick, and the relief on the unconformity above them is up to 100 m. The Eocambrian is about 750 m thick, and the overlying Cambrian rocks are at least 100 m thick. —HRC

John, Edward C. *See* Smith, Wilbur H. 04740

04707 **Johnson, Edward E.; Bennett, Harold J.** An economic evaluation of an ore body, *in* Operations research and computer applications in the mineral industries: Colorado School Mines Quart., v. 64, no. 3, p. 107-128, illus., tables, 1969.

The complexity and interrelationship of the various phases of a mining operation present problems that can be best analyzed by the computer. Applications of the computer for most mine-related problems are in the following areas: (1) ore reserve and inventory computation, (2) cost and equipment analyses, (3) production scheduling, (4) development and mine planning, (5) profitability analyses, (6) resource evaluation, and (7) economic feasibility. —KAF

04969 **Johnson, G. Leonard; Heezen, Bruce C.** Natural hazards to submarine cables: Ocean Eng., v. 1, no. 5, p. 535-553, illus., tables, 1969.

Submarine cable failures from representative marine environments are examined. Sea-floor regions covered are: current swept restricted passages, continental and insular shelves, inter-island oceanic passages, continental and insular slopes, oceanic ridges and the ocean basin floor. Chafe by bottom currents is found to be a potential danger to a depth of 300 fathoms in certain locales. Continental slopes, especially when seaward of a river mouth, are especially hazardous. —Authors' abstract

04810 **Johnson, Gary D.; Vondra, Carl F.** Lithofacies of Pella Formation (Mississippian), southeastern Iowa: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 1894-1908, illus., 1969.

The Pella beds of late Valmeyeran (Meramec) age in southeastern Iowa are designated a formation, and the type section in Marion County, Iowa is described. Three reference sections are also established for the formation. In the 12 counties in southeastern Iowa where the new formation was studied, seven facies of the formation have been recognized and mapped. —SEF

Johnson, Noye M. *See* Bothner, Michael. 04595

04583 **Johnson, Paul Willard.** Common gems of San Diego County, California: Jour. Gemmology, v. 11, no. 7, p. 274-296, illus., 1969.

San Diego County is richly endowed with gem minerals; in its 4,258 square miles more than 140 different minerals have been found. The common gem minerals described herein occur in pockets, or vugs, in granite pegmatite dikes or bodies. The gem mines are in a central mountain belt trending NW-SE, with which the eight pegmatite districts closely coincide. The two principal mining districts are Pala and Mesa Grande. Lepidolite seems to be a valuable indicator of colored gem stones; in the Pala district it has been dated by Rb/Sr method as 106 ± 6 m.y. old. An historical sketch and interesting facts concerning the mineral occurrences are included with descriptions. —GDC

Johnson, R. Roy. *See* LeMone, David V. 04996

05008 **Johnson, Ross B.; Bolyard, Dudley W.; Thurston, W. R.** Second day's road log —Walsenburg to Black Hills, Gardner, Pass Creek, Russell, La Veta Pass, La Veta, Cucharas Pass, Apishipa Pass, Aguilar, Walsenburg, *in* Raton basin field trip, Colorado and New Mexico, 1969, Guidebook: Mtn. Geologist, v. 6, no. 3, p. 166-182, illus., 1969.

This field trip takes one day and is 132 miles long; it makes 5 stops in Mesozoic sedimentary, and Tertiary igneous rocks. Various geological comments are made along the route at geologically interesting points. —HRC

Johnson, S. J. *See* Dansgaard, W. 04852

04516 **Johnson, S. W.; Smith, J. A.; Franklin, E. G.; Moraski, L. K.; Teal, D. J.** Gravity and atmospheric pressure effects on crater formation in sand: Jour. Geophys. Research, v. 74, no. 20, p. 4838-4850, illus., 1969.

Results of an experimental investigation of small explosion craters formed in cohesionless sand suggest that both gravity and atmospheric pressure, when varied, will lead to significant changes in crater dimensions. The ratio of diameters is inversely proportional to the ratio of gravities to the power n, where n increases as the depth of burst of the explosive increases. The n values are less than 0.16. Crater dimensions are less sensitive to changes in atmospheric pressures to about 300 mm Hg than in the range of 300-1000 mm Hg. Diameters of craters formed at pressures between 1.0 and 5×10^{-4} mm Hg were on the average 1.10 ± 0.02 times the diameters of craters formed at pressures near terrestrial atmospheric pressures. Cratering in layers of colored sand was also studied, and effects of pressure and gravity on crater morphology were noted. —*from* Authors' abstract

04831 **Jones, P. B.** Tectonic windows in the Lewis thrust, southeastern British Columbia: Bull. Canadian Petroleum Geology, v. 17, no. 2, p. 247-251, illus., 1969.

Erosion through the Proterozoic sequence in the Clark Range salient has produced windows, two of which, the Cates Creek and Haig Brook, are described. Structure beneath the Lewis thrust consists of an anticline, breaching of which gave rise to the windows. Although the fold in the Lewis plate plunges southeastward, the underlying Sage Creek structure in the Rundle Group plunges northwestward; the Sage Creek structure may be a separate thrust slice. —ESL

04832 **Jones, P. B.** The Tertiary Kishenehn Formation, British Columbia: Bull. Canadian Petroleum Geology, v. 17, no. 2, p. 234-246, illus., 1969.

The Tertiary Kishenehn Formation, exposed along the valley of the North Fork of the Flathead River in southeastern British Columbia and northern Montana, consists of about 8,600 feet of relatively fine-grained lacustrine deposits, overlain by more than 7,000 feet of conglomerates and breccias. Landslide blocks of Proterozoic and Paleozoic rocks occur as clasts several hundred feet across in the upper unit. These blocks were derived from the ancestral Clark Range to the east. The Kishenehn was deposited in a half-graben on the downthrown (west) side of the Flathead fault, concurrently with late movement of the fault, upon an irregular surface eroded in gently dipping Mesozoic and Paleozoic strata. Late movement of the Flathead fault resulted in eastward tilting of the Kishenehn and underlying strata to form the east flank of the MacDonald dome, a broad anticline west of the Flathead Valley. —Author's abstract

04959 **Jurie, Carl A.; Gerhard, Lee C.** Colorado Raton basin—Mineral resources and geologic section, *in* Raton basin field trip, Colorado and New Mexico, 1969, Guidebook: Mtn. Geologist, v. 6, no. 3, p. 81-84, illus., 1969.

Sedimentary rock units of Pennsylvanian through Pleistocene age are exposed in the Colorado part of the Raton basin. These sediments are mainly detrital clastics derived from regional structural highs. Mineral resources of the area have not been fully exploited, although coal has been commercially produced in Las Animas County for many years. Sand and gravel have been extensively extracted for road construction.—Authors' abstract

Kachadoorian, Reuben. *See* Plafker, George. 04454

Kachik, V. J. *See* Chun, D. 04697

Kaiman, S. *See* Harris, D. C. 04392

04736 **Kaliser, B. N.** Bonneville Salt Flats hydrogeological study necessitated by recreational and industrial interests [abs.]: Mining Eng., v. 21, no. 8, p. 44, 1969.

04853 **Katcoff, Seymour.** Alpha-recoil tracks in mica—Registration efficiency: Science, v. 166, no. 3903, p. 382-384, illus., 1969.

Recoils from alpha-particle decay of naturally occurring radioactive nuclides have energies between 70 and 169 kiloelectron volts. It is shown that these alpha recoils register tracks in mica, observable as etch pits, with an efficiency of about 80 percent. When the recoil energy is degraded to 40 kiloelectron volts the efficiency drops to 50 percent. But, since the decay of each Th or U impurity atom in natural mica is followed by a cascade of six or eight alpha particles, the overall registration efficiency must be very nearly 100 percent. —Author's abstract

04411 **Katz, Michael B.** The nature and origin of the granulites of Mont Tremblant Park, Quebec: Geol. Soc. America Bull., v. 80, no. 10, p. 2019-2037, illus., tables, 1969.

These granulites are divided into two groups: pink, quartzofeldspathic rocks and green-gray hypersthenic rocks, which are regionally interbanded. All granulites are intruded by quartz mangerites of the Morin anorthosite suite. Ternary variation diagrams and relations in the Ab-Or-An system show that the two groups have different compositional trends, converging at the granitic end. Under granulite facies conditions, partial anatexis formed granitic melts. This differentiation caused original graywackes to attain a composition appropriate to form hypersthenic rocks and original shales to form quartzofeldspathic rocks with residual sillimanite-garnet layers. Granulite fabrics were produced by deformation during anorthositic intrusion. Volatiles from late-stage granite magmas caused retrograde effects at contacts. —RAL

04961 **Kauffman, Erle G.; Powell, J. Dan; Hattin, Donald E.** Cenomanian-Turonian facies across the Raton basin, *in* Raton basin field trip, Colorado and New Mexico, 1969, Guidebook: Mtn. Geologist, v. 6, no. 3, p. 93-118, illus., 1969.

The rocks include, in ascending order, the upper part of the Dakota Group, Graneros Shale, Greenhorn Limestone, Carlile Shale, and basal beds of the Fort Hays

Limestone. During transgression, these rocks represent four time successive environmental suites. Determination of lateral variation for any sedimentologic unit or block of geologic time is possible through use of a refined system of correlation based on faunal assemblage zones, highly detailed physical stratigraphy, and radiometric control. A refined local biostratigraphic zonation, within which there are some new zones and subzones, is proposed. —*from* Authors' abstract

04517 **Kaula, William M.** A tectonic classification of the main features of the Earth's gravitational field: Jour. Geophys. Research, v. 74, no. 20, p. 4807-4826, illus., tables, 1969.

On the basis of magnitude and extent of mean gravity anomalies, 43 areas from all over the Earth were classed as positive, negative or mild. On the basis of certain patterns of correlation, 11 types of areas were defined. In general, characteristics associated with positive anomalies were dominant over ones associated with mild or negative anomalies, and characteristics associated with recent tectonics dominant over ones associated with ancient. The strongest correlation was between positive gravity anomalies and Quaternary volcanism. Positive correlation with topography residual to a fifth-degree figure is almost universal. The extent to which the different area types relate to the global tectonics varies from strong to negligible. The lack of systematic correlation with temperature indicators indicates that horizontal variations in petrology are significant. —*from* Author's abstract

Kearney, R. J. *See* Jansen, G. J. 04555

04807 **Keefer, William R.** Geology of petroleum in Wind River Basin, central Wyoming: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 1839-1865, illus., tables, 1969.

The Wind River Basin contains more than 60 oil and gas fields developed during Cretaceous and Tertiary times; formations are petroleum bearing. Until latest Cretaceous time central Wyoming was part of the stable shelf that sloped gently westward toward the Cordilleran geosyncline. Regional dip of strata was westward, overburden pressures were greater on the west, and fluids migrated eastward where relations suggest that primary accumulation of hydrocarbons occurred before Laramide folding. Subsidence of the basin area during the Laramide induced a secondary migration of fluids updip toward structural traps along basin margins. Facies changes, unconformities, and porosity and permeability barriers inhibited flushing of all oil and gas from the central basin area, and traps still may be present in the Frontier Formation and older Mesozoic and Paleozoic rocks downdip from the basin margins. —*from* Author's abstract

Keighton, Walter B. *See* McCarren, Edward F. 04776

04841 **Keil, K.** Meteorite composition, Chap. 4 *in* Handbook of geochemistry, V. 1 (K. H. Wedepohl, editor): Berlin and New York, Springer-Verlag, p. 78-115, illus., tables, 1969.

Meteorites are classified into three main groups—stones, stony irons, and irons—and further subdivided on the basis of chemical and mineralogic criteria. Stone meteorites comprise achondrites and chondrites. The former are subdivided into various subgroups whose bulk CaO and FeO/FeO + MgO values are quite distinct; the latter are divided into various types of enstatite, high iron-low metal, and carbonaceous chondrite classes. The stony iron meteorites are generally characterized by significant nickel-iron contents; they are divided into pallasites, siderophyres, lodranites, and mesosiderites. Iron meteorites are classified, mainly on the basis of structure, into hexahedrites, octahedrites, and nickel-rich ataxites. The chemistry of the different groups is discussed, and tabulated data showing average compositions in weight percent and mineral constituents are presented. —MS

04893 **Keith, John R.** Relationships of lead and zinc contents of trees and soils, Upper Mississippi Valley district: Soc. Mining Engineers Trans., v. 244, no. 3, p. 353-356, illus., table, 1969.

Lead and zinc contents of elm, maple, and oak trees and of soils in which the trees grew were determined in samples from the Upper Mississippi Valley mining district, and a contiguous area. The analyses of plant materials served to differentiate mineralized and nonmineralized areas. Stems contained about two times as much zinc as did leaves taken from the same stems. Lead and zinc analysis of all soil horizons could be used to differentiate between the two areas. Soils at most sample sites in the mineralized district seem to be more reliable than plants for geochemical prospecting and are a more practical sampling medium. Soil samples from areas with thick loess cover, however, failed to indicate the presence of mineralized bodies whereas tree samples from the same sites contained anomalous amounts of lead and zinc. It is suggested that in areas of thick loess cover, plant samples could be used in prospecting for lead and zinc. —*from* Author's abstract

04506 **Keller, George V.** Electrical resistivity measurements, Midway and Kure atolls: U.S. Geol. Survey Prof. Paper 680-D, p. D1-D8, illus., 1969.

Electrical resistivity measurements made on recovered core samples, by drill-hole logging, and by surface sounding have been used to estimate porosity of carbonate sediments composing Midway and Kure atolls in the western Hawaiian Islands. Porosities within the first few tens of feet of the surface generally exceed 50 percent by volume but decrease by a factor of two or three at 500 to 1,000 feet deep. Resistivity measurements seem to provide better estimates of porosity than porosity measurements made directly on recovered core samples because of difficulties in collecting an unbiased sample of high-porosity materials. —*from* Author's abstract

04951 **Keller, George V.** Prospecting for deeply concealed ore bodies, *in* Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, p. 60-70, illus., 1969.

In recent years, electrical prospecting methods have been worked out in detail and can now be used in exploration for deep-seated ore bodies. A logical program would consist of high-altitude electromagnetic surveys to locate favorable subcover areas, followed by deep-penetration surface-based induced-polarization surveys, if the nature of the cover permits. Detailed exploration should then be based on various drill-hole-assisted surveys inasmuch as interhole areas could be investigated by electromagnetic transmission surveys. —*from* Author's summary

Kelley, James C. *See* McManus, Dean A. 04423

04874 **Kelly, M.** Quaternary geology of Nordre Stromfjord and its environs, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 27, 1969.

Net sea level displacement at the outer coast has been 150 ± 5 m while at the fjord head the younger displacement is 55 m. Marine sediments, with very complex stratigraphy, also occur in the outer coastal regions. Nunatak moraines of a major ice sheet are very well developed in the coastal mountains of Nordre Isortoq and are presumably of late Wisconsin age. In the fjords, several younger moraine stages, very locally developed, are present. —HRC

04938 **Kent, B. H.; Schweinfurth, S. P.; Roen, J. B.** Geology and land use in eastern Washington County, Pennsylvania: Pennsylvania Geol. Survey, 4th ser., Bull. G56 (General Geology Rept.), 31 p., illus., tables, 1969.

This brief report and accompanying lithologic maps call attention to some aspects of the geology of an eastern part of Washington County, Pa., that affect land utilization; it is not intended to be comprehensive. Background geologic information provided here concerns bedrock, its structure, jointing, general descriptions of rock types involved, map portrayal of areal distribution and thickness of principal sandstone, limestone, and coal beds, and brief discussions of contact springs and landslides. Additional information concerning uses of structure contours and representative analytical data on composition and properties of various rock types are appended. —*from* Authors' abstract

04751 **Kermabon, A.; Gehin, C.; Blavier, P.** A deep-sea electrical resistivity probe for measuring porosity and density of unconsolidated sediments: Geophysics, v. 34, no. 4, p. 554-571, illus., tables, 1969.

A study has been made of the mass physical properties and electrical resistivity of marine sediments. The well-known linear correlation of density with porosity was confirmed. A third-degree polynomial curve was found to be the best fit for the data relating porosity and the formation factor, which is the ratio of the bulk resistivity of marine sediments, to the resistivity of interstitial water. An electrical resistivity probe has been devised to obtain in place profiles of resistivity versus depth. The instrument is 13 m long and weighs 700 kg in water. About thirty rapid measurements on the sea floor can be made in one lowering. Good correlation was obtained between electrical probe measurements and direct porosity measurements made on cores taken nearby. —Authors' abstract

Kesler, Stephen E. *See* Billings, Gale K. 04568

Kessler, L. G., 2d. *See* Brown, L. F., Jr. 04523

Kiersch, George. *See* Varnes, David J. 04483

04635 **Kiesl, Wolfgang.** Determination of trace elements in meteorites by neutron activation analysis, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 302-307, illus., tables, 1969.

The technique of neutron activation analysis is described that was developed for analysis of Se, As, Sb, Sn, Re, Hg, Os, Ru, Zn, Sc, Au, Ir, In, Mo, Ce, Rb, Co, and Cr in meteorites. About 100-200 mg of each meteorite sample is irradiated together with the standards of the elements to be determined. Results obtained for a number of olivine-hypersthene chondrites and for two carbonaceous chondrites of type II are summarized in a table. —VSN

04417 **Kilbourne, Deane E.** Paleomagnetism of some rocks from the Mesaverde Group, southwestern Wyoming and northwestern Utah: Geol. Soc. America Bull., v. 80, no. 10, p. 2069-2073, illus., tables, 1969.

Four stratigraphic sections of Upper Cretaceous sedimentary rocks were sampled and their paleomagnetism measured. The study suggests that a viscous partial thermoremanent magnetization may preserve paleomagnetic data. The pole position plotted from the data obtained does not differ significantly from those obtained from igneous rocks. —RGY

04822 **King, Cuchlaine A. M.** Glacial geomorphology and chronology of Henry Kater Peninsula, East Baffin Island, N.W.T.: Arctic and Alpine Research, v. 1, no. 3, p. 195-212, illus., tables, 1969.

The area was ice-covered at least between 34,000 and 10,000 B.P.The sea was relatively high as the ice withdrew. The marine limit plane slopes 083° from 50 m in the inner areas to 25 m at the outer coast. Planes of synchronous isobases slope down toward 052°. Deglaciation began at 10,000 B.P. at the outer coast, at about 8,500 B.P. in Isabella Bay, and 8,000 B.P. in Itibilung Bay. The last major invasion of fjord ice into the embayments was 8,700-8,000 B.P. This moraine may be contemporaneous with the Cockburn moraine. The ice-cored moraines of the present glaciers have been static for several years. —*from* Author's abstract

04623 **King, John W.** World uranium resources and exploration [abs.]: Mining Eng., v. 21, no. 8, p. 39, 1969.

04412 **King, Philip B.** New tectonic map of North America: Geol. Soc. America Bull., v. 80, no. 10, p. 2039-2041, 1969.

The tectonic map of North America, on a scale of 1:5,000,000, issued by the U.S. Geological Survey in June, 1969 is a companion of the Geologic Map of North America, issued in 1965. An explanatory text has been published simultaneously with the tectonic map as U.S. Geological Survey Professional Paper 628. The entire land area on the map is shown in color. Layer-tinting is used in the cratons to show the relief of their basements and a variety of colors are used in the fold-belts to show, first, their general ages of folding, and second, their division into "structural stages" (time-rock units or facies of like character. —HMB

King, William E. *See* Hawley, John. 04995

Kinney, P. *See* Williams, P. M. 04927

04855 **Kinoshita, Willie T.; Koyanagi, Robert Y.; Wright, Thomas L.; Fiske, Richard S.** Kilauea Volcano—The 1967-68 summit eruption: Science, v. 166, no. 3904, p. 459-468, illus., tables, 1969.

The 1967-68 Halemaumau eruption began with the fountaining in Halemaumau crater along a line of vents oriented in a north-south direction across the crater floor, there being 31 separate episodes of eruption. Shallow harmonic tremor with a predominant period of about 0.5 sec preceded the eruption by about one hour and accompanied all the eruptive phases. During phase 1 to 23, high rates of lava extrusion were accompanied by high tremor amplitude and by an eastward tilt at Uwekahuna (deflation). Low or no output of lava was accompanied by low or no tremor and by a westward tilt (inflation). During phases 24 to 31, the lava output remained almost constant, but the tremor and tilt patterns showed minor fluctuations. Summit deformation and ground cracking during the eruption, rate of extrusion, temperature and composition of the lava and the question of eruption forecasting are discussed. —GV

04507 **Kittrick, J. A.** Interlayer forces in montmorillonite and vermiculite: Soil Sci. Soc. America Proc., v. 33, no. 2, p. 217-221, illus., table, 1969.

Oriented X-ray spacings for vermiculite and montmorillonite were obtained as the sample temperature was changed at a constant rate. Temperatures at which an abrupt change in (001) spacing took place indicated expanding and contracting forces to be dependent upon an ion-water ion-clay force balance. Temperatures at which comparable interlayers of water molecules were removed were higher for vermiculite than for montmorillonite, for Li, Na, Mg, Ca, Sr and Ba ion saturations. Hydration of the negative charge sites is indicated. —Editor's brief

Klausing, R. L. *See* Lofgren, B. E. 04509

Klein, E. *See* LeGeros, R. Z. 04749

04986 **Knowles, C. R.; Smith, J. V.; Bence, A. E.; Albee, A. L.** X-ray emission microanalysis of rock-forming minerals—[Pt.] 7, Garnets: Jour. Geology, v. 77, no. 4, p. 439-451, illus., tables, 1969.

Microprobe analyses for Si, Ti, Al, Mg, Fe, Mn, and Ca in 22 chemically-analyzed and 5 unanalyzed garnets were made independently by authors Knowles and Bence and used to check the correction formulae of Smith (ibid., v. 73, 1965) and Bence and Albee (ibid., v. 76, 1968). Chemical zoning and mineral inclusions complicate the interpretation of the analyses. Agreement between microprobe and chemical analyses is generally good for Mg, total Fe, and Ca, less good for Si, Ti, Al, and Mn. Authors express confidence that microprobe analysis for these major elements can be carried out, even in complex silicates, with an error not exceeding five percent of the amount present and often not exceeding two percent. Further progress will require refinement of correction procedures based on synthetic standards having complex compositions. —BFL

04630 **Koerner, Robert M.** The behavior of cohesionless soils formed from various minerals [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 189B, 1969.

04450 **Komar, Paul D.** The channelized flow of turbidity currents with application to Monterey deep-sea fan channel: Jour. Geophys. Research, v. 74, no. 18, p. 4544-4558, illus., tables, 1969.

Whenever a turbidity current is confined to a channel its upper surface has a cross-channel slope, owing to the combined effects of the Coriolis and centrifugal forces. An equation is developed that balances the Coriolis and centrifugal forces against the pressure force that results from the surface slope. The slope equation is applied to fathograms of 12 crossings taken along a 100-km stretch of the channel that extends from Monterey submarine canyon off central California and crosses the Monterey fan. Solutions of the slope equation give velocities ranging between 600 and 2000 cm per sec. It is found that a reasonable range of Pleistocene slump volumes in Monterey Canyon is capable of generating channel-full turbidity currents of adequate length and time of passage. —KAF

04503 **Komura, Saburo; Simons, Daryl B.** River-bed degradation below dams—Closure [to discussion of paper 5335, 1967]: Am. Soc. Civil Engineers Proc., v. 95, Jour. Hydraulics Div., no. HY 3, p. 1042-1048, illus., 1969.

In reply to comments on this paper (ibid., v. 93, no. HY 4, p. 1-4, 1967) in 1968 discussions, the Kalinske-Brown equation was selected because it was in a most suitable form for the theoretical analysis. Incorporation of a critical friction velocity is permissible, but change in values of a_s and p will not affect the final slope and degradation stage. It is agreed that the critical friction velocity depends on grain size, viscosity, relative density of bed material, flow depth, etc.; these were omitted for simplifying the problem. Suggestions made on problems associated with an armor coat, and on methods are appreciated. It is difficult to include some of the variables thought to be essential. A number of errors are corrected. —GDC

04431 **Kottlowski, Frank E.; LeMone, David V.; Foster, Roy W.** Early Ordovician highlands of Precambrian rocks and their associated facies, *in* The Ordovician symposium—El Paso Geol. Soc., 3d Ann. Field Trip, 1969: El Paso, Tex., El Paso Geol. Soc., p. 134-142, illus., 1969.

Throughout most of southern New Mexico and western Texas, the Precambrian rocks are nonconformably overlain by the Bliss Sandstone which ranges in age from Late Cambrian in the west to Early Ordovician in the east. In most of this region, the Bliss Sandstone is gradationally overlain by the El Paso Limestone of early Ordovician age. The Bliss Sandstone is absent at Thunderbird Mountain where it pinches out against remnant Precambrian rhyolite hills. The lower part of the El Paso Limestone laps onto the rhyolite hill and the higher El Paso limestones completely cover the rhyolite. —KAF

04944 **Kottlowski, Frank E.; Foster, Roy W.** (compilers and editors). Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, 126 p., illus., tables, 1969.

Sixteen papers (cited individually) are the published results of this conference held at New Mexico Technical School in Socorro on May 2 and 3, 1968. Many of the nation's foremost exploration geologists summarize new methods and ideas in mineral exploration, and some new uses for time-tested older methods. —HRC

04945 **Kottlowski, Frank E.** Role of New Mexico Bureau of Mines and Mineral Resources in discovery, *in* Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, p. 2-3, 1969.

The current program of the New Mexico Institute of Mining and Technology's Bureau of Mineral Resources is divided into five groups: metallic ores, industrial rocks and minerals, oil and gas exploration, geologic mapping, and basic research. Examples of the manner in which the Bureau has investigated some areas for the benefit of the mineral industry in the state are cited. The Bureau is 40 years old, has published 92 bulletins, 22 memoirs, 98 circulars, 8 ground-water reports, 78 geologic maps, 26 petroleum exploration maps, 6 resources and land status maps, 8 scenic trips to geologic past guidebooks, 16 annual reports, 22 reprints of important works about the state published elsewhere, and numerous miscellaneous publications. —HRC

Kottlowski, Frank E. *See* Hawley, John. 04995

Kottlowski, Frank E. *See* Hawley, John W. 04997

05005 **Kottlowski, Frank E.** Summary of late Paleozoic in El Paso border region, *in* Border stratigraphy symposium—AAAS S.W. and Rocky Mtn. Div., 44th Ann. Mtg., El Paso, Tex., 1968: New Mexico Bur. Mines and Mineral Resources Circ. 104, p. 38-51, illus., 1969.

Basal Mississippian strata, mainly crinoidal limestones, thicken southwestward in the Pedregosa basin and southeastward in the Delaware basin. Pennsylvanian strata are over 3000 feet thick in the Delaware basin, about 4500 feet thick in the Orogrande basin, and 2400 feet thick in the Pedregosa basin. Wolfcampian strata are 3000 and 4000 feet thick in the Delaware and Orogrande basins. Leonardian strata, as much as 4000 feet thick in the southeast, thin northward and westward, being removed by erosion during early Mesozoic time over the Burro uplift. Guadeloupian strata, 5500 feet thick in the Delaware basin, thin to an eroded edge westward. Ochoan rocks, mainly anhydrite and halite, are concentrated in the Permian basin area, with about 5000 feet being present in the Delaware basin part. —*from* Author's abstract

05006 **Kottlowski, Frank E.; LeMone, David V.** (editors). Border stratigraphy symposium—AAAS S.W. and Rocky Mtn. Div., 44th Ann. Mtg., El Paso, Tex., 1968: New Mexico Bur. Mines and Mineral Resources Circ. 104, 123 p., illus., 1969.

There are nine papers (cited separately) in this symposium, dealing with Precambrian to Late Cenozoic strata. Compilation of rock descriptions in the El Paso area under a single cover should aid future geologic work in the El Paso area. —HRC

Koyanagi, Robert Y. *See* Moore, James G. 04455

Koyanagi, Robert Y. *See* Kinoshita, Willie T. 04855

Kranck, S. H. *See* Moore, J. M., Jr. 04408

04840 **Krauskopf, K. B.** Thermodynamics used in geochemistry, Chap. 3 *in* Handbook of geochemistry, V. 1 (K. H. Wedepohl, editor): Berlin and New York, Springer-Verlag, p. 37-77, table, 1969.

Despite certain shortcomings such as lack of information about reaction rates, thermodynamic concepts and equations are a valuable tool in geochemical studies, particularly in defining the limits of chemical processes in nature. The laws of thermodynamics and various solutions are outlined, as well as the phase rule (with variants and the parameters of phase-rule diagrams), and definitions are formulated for the equilibrium constant, fugacity and activity, free energy, electrode potentials, and other concepts. A list of symbols and a selective list of references to books on specific applications to geologic problems, articles on general aspects of thermodynamics, and compilations of thermodynamic data are appended. —MS

04372 **Kretschmar, U. H.; McNutt, R. H.** The oxide minerals of the Whitestone anorthosite, Dunchurch, Ontario [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 138, 1969.

04787 **Kretz, R.** Examination of intersecting pegmatite dykes and inclusions in dykes near Yellowknife, Canada, *in* Internat. Geol. Cong., 22d, New Delhi 1964, Proc., Sec. 6, Minerals and genesis of pegmatites: Calcutta, India, Internat. Geol. Cong. Organising Comm., p. 1-18, illus., 1964 [1969].

Numerous quartz-feldspar-muscovite pegmatite dikes occur in the eastern margin of the Sparrow Lake Granite pluton and adjacent biotite-cordierite schist of the Yellowknife Group in the Mackenzie District of Canada. Their emplacement has caused offset of earlier dikes, indicating dilation rather than replacement of the enclosing rock. Three examples of intersecting dikes in granite are examined. Apparently conflicting evidence concerning age relationships leads to an interpretation which postulates two or more stages of dilation and pegmatite development. Two or three peg-

matite units of different age exist within single dikes, with only partly discernible contacts. Isolated schist inclusions are explained by repeated pegmatite emplacement. It is concluded that some dikes evolved by slow and continuous dilation of the enclosing rocks concurrent with pegmatite formation. —DBV

Krogh, T. E. *See* Brooks, C. 04340

Kruger, Paul. *See* Linstedt, K. D. 04633

Krumbein, W. C. *See* James, W. R. 04815

Kuhlemeyer, Roger L. *See* Lysmer, John. 04910

04646 **Kujawa, Frank Benedict.** A geometric analysis of stable and metastable phase equilibria in unary and binary systems [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 257B-258B, 1969.

04605 **Kulbicki, G.; Rumeau, J. L.** Caractérisation géochimique des conditions d'oxydo-réduction dans une sédimentation marine carbonatee—Exemple de la Keg River Formation (NW Alberta, Canada) [with English abs.]: Centre Recherches Pau Bull., v. 3, no. 1, p. 155-166, illus., 1969.

A geochemical study of the three lithofacies of the carbonate Keg River Formation in northwestern Alberta has shown characteristic relations between molybdenum, copper, and organic carbon which can be interpreted in terms of oxidation-reduction conditions. It is shown that facies deposited under oxidizing conditions lack any direct correlation between Mo or Cu and organic C, and have low ratios of Mo/organic C and Cu/organic C. In those formed in a reducing environment, however, there is a direct correlation between Mo or Cu and organic C along with enrichment in metals. The ratios Mo/organic C and Mo/Cu increase in value with increase in reducing conditions. —VSN

04596 **Kumezawa, Mineo.** The elastic constant of polycrystalline rocks and nonelastic behavior inherent to them: Jour. Geophys. Research, v. 74, no. 22, p. 5311-5320, illus., tables, 1969.

A discussion is presented on the physical significance of the Voigt, Reuss, and Hill averaging methods of calculating the isotropic properties of anisotropic crystals and the bulk properties of polycrystalline aggregates of solids. It is shown: (1) that Reuss' average rather than Hill's average is to be identified with the elastic constant that is observed under high-pressure static compression of rocks, (2) that Reuss' average is also suitable for the isotropic representation of an anisotropic crystal, and (3) that the difference between the Reuss and Hill values is a measure of the nonelastic properties of rocks.—Author's abstract

04931 **Kutina, Jan.** Hydrothermal ore deposits in the western United States—A new concept of structural control of distribution: Science, v. 165, no. 3898, p. 1113-1119, illus., tables, 1969.

Empirical plotting of four sets of equidistantly spaced shear stress trajectories, based on regularities in distribution of actual faults and ore veins in the continental area and on the landward prolongation of the big fracture zones of the northeastern Pacific, gives rise to a prospecting net for the western United States. Preferential accumulation of big ore deposits along landward prolongation of the main fracture zones of the northeastern Pacific, in the vicinity of intersections of four systems of trajectories, and along boundaries of crustal blocks suggests several possibilities for prospecting for unknown hydrothermal deposits in the Cordilleran part of the United States. —*from* Author's abstract

LaFleur, Philip D. *See* DeVoe, James R. 04631

Lagaay, R. A. *See* Collette, B. J. 04727

Lajoie, K. R. *See* Christensen, M. N. 04600

04972 **Lambert, R. St.J.; Simons, J. G.** New K/Ar age determinations from southern West Greenland, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 68-71, table, 1969.

Absolute ages are reported for four samples from the pre-Ketilidian/pre-Nagssugtoqidian central gneiss complex in which there are several amphibolite-facies linear belts with conformable greenschist layers that contrast on a major scale with the completely folded granulite facies complexes: (1) hornblende from Sungasanuat, Fiskenaesfjorden, 3210 ± 80 m.y., (2) hornblende from South Qilanfarssuit Island, east of Bukesfjord, 2535 ± 60 m.y., (3) hornblende from southeast Björneöen, Godthaabsfjord, 2410 ± 60 m.y., and (4) hornblende from the Godthaab-Isua belt, 1940 ± 50 m.y. The figures are regarded as relating to the age of cooling of the various sectors of the complex following initial crystallization of the minerals dated. —HRC

04666 **Lamont, Norman.** Are all those logs *really* necessary,: Log Analyst, v. 10, no. 3, p. 44-47, illus., 1969.

[In re-examining three examples from a paper by Tixier et al (1968, ibid., v. 9, no. 6) called the "Sandstone Analysis Log", it is concluded that] The computed analysis log that requires several different porosity logs for input data is not needed in the Gulf Coast to locate hydrocarbon-bearing low resistivity sands, provided: (1) an SP, Induction, short-normal and a reliable porosity log are available (b) a competent, experienced log analyst is available to interpret these logs; (c) the decision makers do not "know" already that oil or gas is not to be found in the low resistivity sands. —Author's abstract

04418 **Langford, G. B.** Memorial to Wilson Moorhouse (1913-1969): Canadian Mineralogist, v. 10, pt. 1, p. 1-3, portrait, 1969.

Langway, C. C., Jr. *See* Dansgaard, W. 04852

04971 **Larsen, Ole.** K/Ar age determinations, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 62-67, table, 1969.

Dating was done on samples from five different areas of Greenland: (1) pseudotachylite from the Agto area is 3070 ± 70 m.y., (2) four samples of recrystallized pillow lava from the Ketilidian region had one good sample which was dated at 910 ± 80 m.y., (3) two nepheline syenite samples from Grönnedal are 1210±30 and 1170 ± 35 m.y. old, and (4) a sample of migmatite from the Tingmiarmiut area is 2190 ± 50 m.y. old, and (5) three samples from the Scoresby Sund area are 435 ± 12 m.y. for two of them, and 616 ± 15 m.t. (biotite) and 406 ± 10 m.y. (muscovite) for the other. The 600 m.y. range is consistent with the Caledonian orogeny. —HRC

04911 **Lasca, N. P.** The surficial geology of Skeldal, Mesters Vig, northeast Greenland: Medd. Grönland, v. 176, no. 3, 56 p., illus., tables, geol. map, 1969.

Surficial deposits of Skeldal, a northeast-trending valley heading in the glaciers of Staunings Alper, were studied and sampled for laboratory analysis. Radiocarbon dates have helped to establish a chronology for glacial retreat, in six phases: (1) maximum height of ice surface about 500 m, corresponding to the Wisconsin glacial maximum; (2) downwasting from the 500 m level; (3) glacial readvance to a 300 m level; (4) general emergence of the Mesters Vig district during postglacial time, beginning about 10,000 B.P.; (5) a post-1,500 B.P. glacial readvance; (6) recession of glaciers and development of modern landscape. The rate of emergence, related to glacial unloading, was about 3 m per 100 years from 8,000 to 7,000 B.P., about 1 m per 100 years between 6,500 and 6,000 B.P. and, since then, about 6-7 cm per 100 years. —VMJ

Laul, J. C. *See* Case, D. R. 04616

04561 **Laurence, Robert A.** Evolution of thought on ore controls in the southern Appalachian Valley [abs.]: Econ. Geology, v. 64, no. 3, p. 351-352, 1969.

04735 **Lawrence, H. W.** Well logging techniques as applied to geological engineering [abs.]: Mining Eng., v. 21, no. 8, p. 44, 1969.

04952 **Lawrence, H. W.; Baltosser, R. W.** Engineering problems and downhole geophysical solutions, *in* Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, p. 71-85, illus., table, 1969.

Continuous velocity logging, a technique used generally in the petroleum well-drilling industry, has applications in the mining core-drilling industry, some of which are described. The CVL system depends upon refraction and mode conversion to get the sonic signal from the transmitter to the receiver. Several different wave types travel at different velocities through different materials so the resulting log is very complex; various types of electronic receivers which convert them to readable records are described. In one case, the signal can be displayed on an oscilloscope, and when altered by moving film, resulting in a variable density display, called the 3-D Velocity Log. Numerous applications of this tool are outlined, including analyses of Young's modulus and the shear modulus of materials in the hole. —HRC

04921 **Layer, D. B.; Sproule, J. C.** Robert William Landes (1910-1969): Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 2015-2016, portrait, 1969.

04459 **Leakey, Louis S. B.; Clements, Thomas; Simpson, Ruth D.** A search for Pleistocene archeological evidence in the Calico Mountains of eastern California, *in* National Geographic Society research reports 1964 (Paul H. Oehser, editor): Washington, D.C., Natl. Geog. Soc., p. 219-225, 1969.

A detailed account of the nature of the excavation of an alluvial fan bordering the Calico Mountains, California, is given. The fan was deposited in very early Wisconsin or during the third interglacial intervals, and detailed excavation revealed stone implements which were stated by Leakey to be primitive hand axes, but which were questioned by other archeologists in the area. Flaked material encountered is suggestive of ancient occupation. At depth, the fan was cemented by calcium carbonate so that digging became very burdensome, but the excitement of possibly turning up archeological material kept the interest and the work going; the crew members worked with dedication because they had come to believe in the archeological potential of the site. The fan material makes up the Yermo Formation in the region. —HRC

04632 **Leddicotte, G. W.** Specific activation analysis techniques and methods for the assay of trace substances in aquatic and terrestrial environments, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 76-80, tables, 1969.

Samples of water, soil, stream sediments, dusts, vegetation, and similar materials from aquatic and terrestrial environments have been assayed for trace elements. Techniques, apparatus, procedures, and results are discussed briefly. The studies are concerned primarily with environmental pollutants. Neutron activation analysis was the method used for detection of these elements; the method involves nondestructive and radiochemical processing of irradiated materials and chemical separations to complete the radiochemical portion of the assay as needed. Data are tabulated for various elements in deep spring and industrial waters, pesticide residues in vegetation, and trace elements in soils. —VSN

LeGeros, J. P. *See* LeGeros, R. Z. 04749

04749 **LeGeros, R. Z.; Trautz, O. R.; Klein, E.; LeGeros, J. P.** Two types of carbonate substitution in the apatite structure [with German abs.]: Experientia, v. 25, no. 1, p. 5-7, illus., tables, 1969.

The apatite structure allows varied substitutions to take place without a significant alteration in its basic structure; the substitutions are manifested by changes in lattice parameters of the apatite depending on size of substituting cation or anion. Results are reported briefly on X-ray diffraction analysis and IR-absorption studies on

synthetic apatites prepared (1) at 900-1000°C with exclusion of water, and (2) from aqueous systems by direct precipitation and by conversion of monetite in carbonate solutions at 100°C. Human dental enamel apatite was also studied. The IR-absorption spectra of biological apatites are similar to those of precipitated apatites in which CO_3-for-PO_4 substitution takes place. —MCM

LeGrand, H. E. *See* Stringfield, V. T. 04719

04560 **LeGrand, Harry E.; Stringfield, Victor T.** Tertiary limestone aquifer system in the southeastern United States [abs.]: Econ. Geology, v. 64, no. 3, p. 352, 1969.

04427 **LeMone, David V.** Cambrian-Ordovician in the El Paso border region, *in* The Ordovician symposium—El Paso Geol. Soc., 3d Ann. Field Trip, 1969: El Paso, Tex., El Paso Geol. Soc., p. 145-161, 1969.

The Cambrian-Ordovician of the El Paso border region is represented by two basin rock units. The lower unit (Late Cambrian,-Early Ordovician) consists of Bliss Sandstone and El Paso Group, and is time-transgressive; it is older in the west and younger in the east. The upper unit (Montoya Group-Upper Ordovician) is separated from the lower by a profound regional angular unconformity. The Montoya Group consists of four basic units that have been correlated from the El Paso area to northern Greenland: (1) an unnamed, sporadically occurring sandstone (Harding-Winnipeg erosion remnants); (2) Upham Formation; (3) Aleman Formation; and (4) the Cutter Formation. —KAF

04428 **LeMone, David V.** Ordovician type localities, *in* The Ordovician symposium—El Paso Geol. Soc., 3d Ann. Field Trip, 1969: El Paso, Tex., El Paso Geol. Soc., p. 162, 1969.

Locations of type localities are given for 15 Ordovician formations in Texas and New Mexico. —KAF

LeMone, David V. *See* Kottlowski, Frank E. 04431

LeMone, David V. *See* Hawley, John. 04995

04996 **LeMone, David V.; Johnson, R. Roy.** Neogene flora from the Rincon Hills, Dona Ana County, New Mexico, *in* Border stratigraphy symposium—AAAS S.W. and Rocky Mtn. Div., 44th Ann. Mtg., El Paso, Tex., 1968: New Mexico Bur. Mines and Mineral Resources Circ. 104, p. 77-88, illus., 1969.

The opalized flora is in the upper Santa Fe Group (Pleistocene). A new grass *Palaeophragmites gilei* is described; *Scirpus hawleyi, S. kottlowskii, Eleocharis todsenii,* and *Iris seageri* are also new. Additional materials, yet unclassified, including large striated stems, large, round stems (tree or shrub), and assorted round stems from woody angiosperms have been recovered. The environment of the flora is interpreted to be a spring-fed cienega. Current vegetation is typical of Southern Desert Shrub at the northern periphery of the Chihuahuan desert. Heterogeneity of terrain (and geology) contributes to a diverse flora of shrubs, with few, mostly epithermal annuals, and suffrutescent perennials. Trees are absent except along larger arroyos. —*from* Authors' abstract

05003 **LeMone, David V.** Cambrian-Ordovician in El Paso border region, *in* Border stratigraphy symposium—AAAS S.W. and Rocky Mtn. Div., 44th Ann. Mtg., El Paso, Tex., 1968: New Mexico Bur. Mines and Mineral Resources Circ. 104, p. 17-25, table, 1969.

The lower of two Late Cambrian(?)-Lower Ordovician units, the Bliss Sandstone and El Paso Group, is time transgressive; it is older in the west and younger in the east. There is a complex series of transgressions and regressions rather than a simple west-to-east transgression; it is thickest in the south. The upper unit (Montoya Group-Upper Ordovician) is separated from the lower by a profound regional angular unconformity, and consists of four basic units that have been correlated from El Paso to

northern Greenland. These include an unnamed, sporadically occurring sandstone (Harding-Winnipeg erosion remnants), the Upham Formation, including the basal, locally developed Cable Canyon Sandstone (Red River); the Aleman Formation (Lower Richmond); and the Cutter Formation (Upper Richmond). All four units are separated by regional disconformities. —*from* Author's abstract

LeMone, David V. *See* Kottlowski, Frank E. 05006

Leonard, R. A. *See* Weed, S. B. 04508

04510 **Leve, G. W.; Goolsby, D. A.** Production and utilization of water in the metropolitan area of Jacksonville, Florida: Florida Div. Geology Inf. Circ. 58, 37 p., illus., tables, 1969.

Large quantities of water are available from numerous surface streams and underground aquifers in the Jacksonville area; water in most of the surface streams is brackish at least part of the year and has limited industrial use. Potable water supplies are obtained from wells drilled into one of three aquifers: surficial sand beds (poor quality); limestone, shell and sand beds between 50-150 feet below the surface (hard and locally high in iron); and limestone and dolomite beds (Floridan aquifer) more than 300-600 feet below the surface and about 1,600 feet thick, the principal source. In 1966 162 mgd were withdrawn from the Floridan. —*from* Authors' abstract

Levinson, A. A. *See* Taylor, S. R. 04900

04960 **Lewis, Christopher J.; Wilde, Donald E.; Gerhard, Lee C.** Basement structure map of the Raton basin area, Colorado, *in* Raton basin field trip, Colorado and New Mexico, 1969, Guidebook: Mtn. Geologist, v. 6, no. 3, p. 85-86, illus., 1969.

A small-scale isostructural map on the Precambrian surface reflects the Pennsylvanian Ancestral Rocky Mountain orogeny and the Cretaceous Laramide orogeny. The dominant structural trend is northwest, with a second, less well-developed northeastern trend. The Ute Pass fault, the Wet Mountain upthrust, the Apishapa arch, the La Veta syncline, and the Sangre de Cristo complex thrust zone are the major tectonic elements which determine the configuration. The northeast-trending structures include the Delcarbon syncline, a possible shear zone to its northwest, and a part of the Los Animas-Sierra Grande arch system. —HRC

04681 **Lewis, Trevor.** Terrestrial heat flow at Eldorado, Saskatchewan: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1191-1197, illus., tables, 1969.

A heat flow of $1.2 \pm .1$ μcal $cm^{-2}s^{-1}$ has been measured in a mine at Eldorado, Saskatchewan. The uncertainties in the correction to this value for climatic changes caused by the most recent glaciation are a minimum at the depth at which this measurement was made. A terrestrial heat flow value, representative of the area, was obtained by using a two-dimensional conductivity model of the mine; this value is $1.3 \pm .1$ μcal $cm^{-2}s^{-1}$.—Author's abstract

04806 **Libby, Fred.** An inexpensive shallow water table probe: Jour. Geology, v. 77, no. 5, p. 626-628, illus., 1969.

Plans for a perforated prod rod for probing shallow water tables are presented. The instrument has been successfully used in surveys along the Santa Ynez River, California. —JCR

04858 **Liberty, B. A.** Palaeozoic geology of the Lake Simcoe area, Ontario [with French abs.]: Canada Geol. Survey Mem. 355, 201 p., illus., tables, geol. map, 1969.

The flat-lying lower Paleozoic shelf carbonates are described. Ordovician strata are divided into two main groups, the Simcoe Group with four formations, and the Nottawasaga Group with two. Long-standing stratigraphic problems of the Middle Ordovician are resolved, and Ordovician strata in southern Ontario now have a dual nomenclature, one biostratigraphic, the other lithostratigraphic. Stratigraphic details

reveal a northwest-trending structure in the Peterborough area, and a structurally controlled lineation of lakes between Georgian Bay and Belleville, herein called the Kawartha Lineament. The area contains many quarries, only a few operating, which produce crushed stone, agricultural lime, and asphalt filler. Basic chemical data is included for the variety of carbonate rocks in anticipation of future commercial development. —*from* Author's abstract

Liberty, B. A. *See* Caley, J. F. 04859

04633 **Linstedt, K. D.; Kruger, Paul.** Neutron activation analysis of vanadium in natural waters, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p.87-92, illus., tables, 1969.

Because of the high dissolved solids content of many natural waters, analyses for vanadium are best made using the neutron activation method owing to its inherent sensitivity and isotope selectivity. For quantitative activation analysis, it is necessary to include pre-irradiation sample concentration in addition to postirradiation radiochemical separations. Techniques are discussed and a procedure flow sheet is given for neutron activation analysis of vanadium in natural water with concentration of dissolved solids. Vanadium analyses are given for standard samples and for various natural river waters. —VSN

Lipschutz, M. E. *See* Case, D. R. 04616

04509 **Lofgren, B. E.; Klausing, R. L.** Land subsidence due to ground-water withdrawal, Tulare-Wasco area, California: U.S. Geol. Survey Prof. Paper 437-B, p. B1-B103, illus., tables, 1969.

Intensive pumping of ground water has caused more than 800 sq mi of irrigable land to subside in the Tulare-Wasco area of southeastern San Joaquin Valley, Calif. Locally, ground-water levels declined up to 200 feet between 1905 and 1964, and maximum subsidence was 12 feet by 1964. Subsidence was due to compaction of water-yielding deposits as intergranular effective stresses increased. Magnitude and rate of subsidence are related to change in effective stress within the compacting beds resulting from water-level changes and the thickness and compressibility of compacting deposits. The annual rate of subsidence varies in direct response to seasonal pumping. Additional subsidence can be kept at a minimum by reducing withdrawal or by wider dispersal of withdrawal wells. Slight rebound has been observed in areas of large water-level recovery. —*from* Authors' abstract

04471 **Lofgren, Ben E.** Land subsidence due to the application of water, *in* Reviews in engineering geology, V. 2 (D. J. Varnes and George Kiersch, editors): Boulder, Colo., Geol. Soc. America, p. 271-303, illus., tables, 1969.

This process, here referred to as hydrocompaction, has produced widespread subsidence of the land surface. It may occur under natural overburden load or only with the addition of surcharge load. Deposits that subside because of hydrocompaction are of two types: (1) loose, moisture-deficient alluvial deposits, and (2) moisture-deficient loess and related eolian deposits. Such deposits occur in regions where rainfall seldom, if ever, is sufficient to penetrate below the root zone; thus they have remained moisture deficient throughout their postdepositional history and are readily susceptible to hydrocompaction when they are artificially wetted. Damage can usually be minimized by precompacting the deposits before construction begins. —*from* Author's abstract

04462 **Long, Leon E.** Whole-rock Rb-Sr age of the Yonkers Gneiss, Manhattan Prong: Geol. Soc. America Bull., v. 80, no. 10, p. 2087-2090, illus., tables, 1969.

The intimately associated Yonkers and Fordham Gneisses are the oldest formations in the Manhattan Prong. A whole-rock Rb-Sr isochron determined from the Yonkers Gneiss corresponds to an age of 575 ± 30 m.y., and initial Sr-87/Sr-86 = 0.725 ± 0.008. The Manhattan Prong rocks are thus distinctly younger than the adjacent

Hudson Highland gneisses. The Fordham and Yonkers Gneisses were involved in major tectonism around 575 m.y. ago, but the nature of the event is obscured by more recent Paleozoic deformation and metamorphism. —Author's abstract

Long, Leon E. *See* Barker, Daniel S. 05001

04489 **Lorenzo, Jose L.** Minor periglacial phenomena among the high volcanoes of Mexico [with French and Spanish abs.], *in* The periglacial environment, past and present (T. L. Péwé, editor)—Internat. Assoc. Quaternary Research, 7th Cong., Alaska, 1965: Montreal, Quebec, McGill-Queen's Univ. Press, p. 161-175, illus., 1969.

Periglacial phenomena exist on the higher Mexican volcanoes as structural and textural soils but are restricted to small areas close to existing glaciers. Amorphous frost soils occur in the mountain pastures at lower altitudes but still above the tree-line. "Fossil" periglacial examples are very few and the amorphous frost soil type is absent in the "fossil" state. The scarcity of existing examples of periglacial phenomena, even near the glaciers, when compared with the even lesser number of fossil examples leads one to think that periglacial phenomena in tropical zone mountains, even though present, was never widespread. Their very existence was controlled by the topoclimate existing at the glacier border. The periglacial phenomena in Mexico today are typical of the daily climatic fluctuations as was probably true in the past.—*from* Author's abstract

04373 **Louisnathan, S. John.** The crystal structure of gehlenite $Ca_2Al(Al, Si)_2O_7$ [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 138, 1969.

04773 **Lounsbury, John F.; Ogden, Lawrence.** Earth science: New York, Harper and Row, 372 p., illus., tables, 1969.

This text for a one-semester introductory course in general education can be used also for an introductory course for students who plan to concentrate in the fields of geology or geography. Chapter headings are: Earth as a planet; composition and structure of the atmosphere, temperature phenomena; air pressure, winds, and moisture; air masses, cyclones, and violent storms; oceans; world climates; solid earth, minerals and rocks; vulcanism, tectonics, earthquakes and Earth's interior; rock weathering, soil formation, and geologic time; mass wasting, streams, and ground water; glaciation and wind action; coastal landforming processes; Earth history; and world patterns. —MCM

04360 **Lovejoy, Earl M. P.** The infra-Paleozoic contact, southern Franklin Mountains, *in* The Ordovician symposium—El Paso Geol. Soc., 3d Ann. Field Trip, 1969: El Paso, Tex., El Paso Geol. Soc., p. 104-109, illus., 1969.

Evidence has been found along five miles of the infra-Paleozoic contact of the southern Franklin Mountains that both the Thunderbird rhyolite and the Red Bluff granite intrude the lowest unit of the so-called Bliss sandstone and the lower El Paso Group limestone. —KAF

04457 **Lovell, J. P. B.** Tyee Formation—Undeformed turbidites and their lateral equivalents, mineralogy and paleogeography—Reply [to discussion by J. J. W. Rogers, 1969]: Geol. Soc. America Bull., v. 80, no. 10, p. 2131-2132, 1969.

Lovell in reply to a discussion by J. J. W. Rogers (ibid., p. 2129-2130)reasserts his belief that the Klamath Mountains are an adequate provenance for the Tyee Formation, are not cratonic, and are not to be postulated as the source of all the detritus that accumulated in the Tertiary eugeosyncline of Washington and Oregon. —RGY

04430 **Lucia, F. J.** Sedimentation and paleogeography of the El Paso Group, *in* The Ordovician symposium—El Paso Geol. Soc., 3d Ann. Field Trip, 1969: El Paso, Tex., El Paso Geol. Soc., p. 110-133, illus., 1969.

The El Paso Group in the Franklin Mountains at El Paso, Texas, is divided into formations on the basis of gross sedimentation. The following four general sediment

types are recognized: massive marine carbonate, alternating marine and mud-flat carbonate, podoshaped bodies of fossiliferous wackestone enclosed in dark packstones and beds of alternating marine carbonate and algal stromatolites, and shoreline sediments, including tidal channel, intertidal, and supratidal sandy carbonates. The Diablo Arch was a positive feature during sedimentation of the El Paso Group. Tidal flat sedimentation was dominant along the arch. Twice during El Paso time, tidal flat sedimentation prograded as far west as the Franklin Mountains, producing the Chamizal and Cindy formations. —KAF

04415 **Lutton, R. J.** Systematic mapping of fracture morphology: Geol. Soc. America Bull., v. 80, no. 10, p. 2061-2065, illus., 1969.

Detailed examination of fracture surfaces reveals characteristic features that can be represented by a system of mapping symbols. The symbols apply equally well for features of all nonshear fracture surfaces in a variety of materials and scales. The system is believed to be valid through a range of material types and loading conditions of seven or more orders of magnitude. —*from* Author's abstract

04647 **Luttrell, Eric Martin.** An analysis of the Silurian Keefer Sandstone of Pennsylvania [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 258B-259B, 1969.

04442 **Luyendyk, Bruce P.** Origin of short-wavelength magnetic lineations observed near the ocean bottom: Jour. Geophys. Research, v. 74, no. 20, p. 4869-4881, illus., 1969.

Recent magnetometer measurements over the Mason-Raff type of magnetic anomalies made close to the ocean floor reveal anomalies of shorter wavelength and higher amplitude than are measured at the ocean surface. These anomalies are lineated and parallel to the topography and anomalies at the ocean's surface in an area in the northeastern Pacific. They are caused by slowly and continuously changing magnetization within the oceanic second layer, in a direction perpendicular to the lineations. These fluctuations in magnetization are probably due to time variation in paleofield intensity. If the oceanic crust faithfully records these paleofield fluctuations, the history of the behavior of the Earth's field and thus the Earth's interior may be studied by magnetic observations near the ocean floor. —DBV

04910 **Lysmer, John; Kuhlemeyer, Roger L.** Finite dynamic model for infinite media: Am. Soc. Civil Engineers Proc., v. 95, paper 6719, Jour. Eng. Mechanics Div., no. EM4, p. 859-877, illus., 1969.

A numerical method for the dynamic analysis of infinite continuous systems is developed. The method is applicable to systems for which all exciting forces and geometrical irregularities are confined to a limited region and is applicable to both transient and steady state problems. The infinite system is replaced by a system consisting of a finite region subjected to a boundary condition which simulates as energy absorbing boundary. The resulting systems may be analyzed by the finite element method. Examples applying the method to foundation vibration problems are presented. Good agreement with existing solutions is found and new results for embedded footings are presented. —ASCE abstract

04968 **Mackenzie, J. D.** Ceramics in ocean engineering: Ocean Eng., v. 1, no. 5, p. 555-571, illus., tables, 1969.

Ceramics, both crystalline and noncrystalline, have long been used as materials of engineering. Recently, there has been an increasing interest in the possible use of ceramics in ocean engineering. In this review, some of the more important basic concepts regarding ceramics are presented primarily for engineers with relatively limited knowledge of such materials. Those properties which are of particular importance to ocean engineering and some of the practical results of applications in ocean environment are also discussed. Conventional ceramics, glasses and glass-ceramics are separately treated. —Author's abstract

04374 **MacLean, W. H.** The role of oxidation in the genesis of magmatic sulfide deposits [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 138-139, 1969.

04574 **Maher, Stuart W.** Regional distribution of mineral deposits beneath the pre-Middle Ordovician unconformity in the southern Appalachian Valley [abs.]: Econ. Geology, v. 64, no. 3, p. 352-353, 1969.

04833 **Malklem, W. R.; Bebout, D. G.; Glaister, R. P.** Classification of anhydrite—A practical approach: Bull. Canadian Petroleum Geology, v. 17, no. 2, p. 194-233, illus., 1969.

The inconsistent usage of anhydrite terms in the past has pointed out the need to standardize terminology. To answer the need, we have developed a practical anhydrite classification in which two basic properties are considered—structures and textures. The structural types are classified on the basis of four parameters: external form, anhydrite-to-matrix relationship, bedding, and distortion. The textural types are classified by size, shape, and spatial relationship of the crystals within the anhydrite masses. This anhydrite classification is believed to have world-wide applicability. —Authors' abstract

04621 **Malan, R. C.; Sterling, D. A.** Distribution of uranium and thorium in Precambrian rocks of the southwestern U.S. [abs.]: Mining Eng., v. 21, no. 8, p. 38, 1969.

04823 **Malott, D. F.** Uses of geophysics in subsurface surveying: Soc. Mining Engineers Trans., v. 244, no. 3, p. 259-267, illus., 1969.

The Michigan Department of State Highways makes extensive use of geophysics for subsurface surveying which would be applicable for uses in other fields. Examples of resistivity surveys are given which include a proposed large-volume excavation with suggestions for land use after excavation, subsurface evaluation for engineering design, and a subsurface survey for land appraisal. An example of a combined refraction seismic and resistivity survey is shown where the resistivity is used for outlining the unconsolidated soils, while the seismic method is used to outline bedrock and to evaluate it for rippability. A refraction seismic survey at the bottom of bridge caissons for evaluation of bedrock uniformity and a relative aid in assessing rock strength is reported. —Author's abstract

04954 **Malott, James P.** New ideas in the worldwide exploration of petroleum and production of petroleum [abs.], *in* Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, p. 97, 1969.

04375 **Mandarino, J. A.; Matzat, E.; Williams, S. J.** Zemannite, a new tellurite mineral from Moctezuma, Sonora, Mexico [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 139-140, 1969.

04615 **Mandler, John W.; Reed, John H.** Neutron techniques for *in situ* elemental analysis, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 404-408, illus., 1969.

A combined neutron activation instrument simultaneously employing capture analysis, inelastic neutron scattering, and activation gamma-ray spectra analysis has been developed for *in situ* analysis of rocks. The combined instrument, also including thermal neutron die-away techniques, was originally developed for use in spacecraft. Gamma-ray spectra from large samples of basalt and granite using a Pu-Be neutron source as well as a pulsed 14 MeV neutron source and NaI(Tl) and Ge(Li) detectors are discussed here. Data obtained using the isotopic neutron source contain far more useful information when a high resolution solid state detector is used. If a Na(Tl) detector must be used, it is advantageous to use a pulsed neutron generator for timing purposes; if a Ge(Li) detector is used, a pulsed neutron generator offers little advantage over an isotopic source. —VSN

04409 **Manning, P. G.; Nickel, E. H.** A spectral study of the origin of colour and pleochroism of a of a titanaugite from Kaiserstuhl and of a riebeckite from St. Peter's Dome, Colorado: Canadian Mineralogist, v. 10, pt. 1, p. 71-83, illus., 1969.

Polarized spectra of a-b sections of titanaugite (from Germany) show a pleochroic band at about 14000 cm^{-1} assigned to $Fe^{2+} \rightarrow Fe^{3+}$ charge-transfer. Intra-cationic d-d

bands of octahedrally-bonded Fe^{2+}, Fe^{3+}, and Ti^{3+} were observed at 10000 cm^{-1}, 22000 cm^{-1}, and 19000 cm^{-1} respectively. Polarized spectra of a-c sections of riebeckite from St. Peter's Dome, Colorado, show pleochroic band at 15700 cm^{-1} polarized along metal-metal directions; it is assigned to $Fe^{2+} \rightarrow Fe^{3+}$ charge-transfer. The field-independent transition $^6A_1 \rightarrow {}^4A_1{}^4E(G)$ in Fe^{3+} is observed at 23000 cm^{-1}. Intra-cation d-d bands of Fe^{3+} appear as weak shoulders on the limb of the 15700 cm^{-1} band. —*from* Authors' abstract

04617 **Mantel, M.; Gilat, J.; Amiel, S.** Isotopic analysis of uranium by neutron activation and high resolution gamma-ray spectrometry, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 482-489, illus., tables, 1969.

Use of Ge(Li) detectors permit high resolution gamma-ray spectrometry for simultaneous determination of numerous separate gamma-ray peaks belonging to different species present in one sample. The ratio U-238/U-235 in a uranium sample may be determined from the ratio of peak intensities of Np-239 formed from U-238 by activation and those of fission products formed from U-235; several Np-239 peaks as well as those of a number of fission products can be easily distinguished. Since each spectrum yields more than one peak ratio, precision can be increased by averaging over several. Results are reported here of analysis of a sample of natural uranium NBS Standard Reference Material No. 950. Comparisons are made with analyses obtained by neutron activation followed by counting of delayed neutrons. —VSN

Mao, Ho Kwang. *See* Takahashi, Taro. 04932

Marcantel, E. L. *See* Moore, C. H., Jr. 04502

04526 **Marcantel, Emily Laws.** The Skelly-Hobbs rudist reef complex, *in* A guidebook to the depositional environments and depositional history, Lower Cretaceous shallow shelf carbonate sequence, west-central Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 19-39, illus., 1969.

The Edwards Formation in west-central Texas contains many rudist-bearing units. These rudists occur as single specimens, localized patches or accumulations of debris. However, only one rudist reef was found in west-central Texas. This reef is exposed in and around the Skelly-Hobbs oil field in northeastern Nolan County. The purpose of this paper is to develop the geometry of the Skelly-Hobbs rudist reef complex, the zonation of the rudists and associated fauna within the reef, the lateral relationships of reef to equivalent rocks, and a plausible depositional history of the reef complex. —*from* Author's introduction

Marcantel, J. B. *See* Moore, C. H., Jr. 04502

04528 **Marcantel, Jonathan B.** The origin and distribution of Lower Cretaceous dolomites in west-central Texas, *in* A guidebook to the depositional environments and depositional history, Lower Cretaceous shallow shelf carbonate sequence, west-central Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 75-104, illus., 1969.

The dolomites of the area were deposited on a broad, very shallow to emergent area with restricted circulation. As the dolomites were forming, normal marine shelf limestones were being deposited to the northeast in the East Texas Embayment. These limestone sequences are thicker than the dolomites, so that the west-central area was a broad divide or platform, both topographically and tectonically separating two more rapidly subsiding, deeper intrashelf basins (the Concho arch). This shallow platform was then the site of extensive tidal flat sedimentation at or near sea level, throughout most of Fredericksburg time, giving rise to the general NW-SE trend of the Fredericksburg dolomites (general trend of the Concho arch). —*from* Author's summary

Margason, B. E. *See* Caudle, W. N. 04950

04804 **Margulis, Lynn.** New phylogenies of the lower organisms—Possible relation to organic deposits in Precambrian sediment: Jour. Geology, v. 77, no. 5, p. 606-617, illus., tables, 1969.

Classical phylogenies of the lower organisms, for example those based on the traditional difference between plants and animals, involve assumptions recently claimed to be erroneous. Alternative assumptions, more consistent with modern genetic and biochemical data, lead to construction of new phylogenies. The new phylogenies, one for prokaryote organisms (nucleoid, but not membrane bound) and one for eukaryote organisms (membrane-bounded nucleus), which are based on the symbiotic theory of origin of eukaryotic organelles, can be used to predict the nature and sequence of organic deposits on the Precambrian Earth. Even if incorrect, these phylogenies establish a modern framework for comparison and description of organic remains in sediment. —*from* Author's abstract

05007 **Mark, Anson; Requist, Norris.** First day's road log—Trinidad to Walsenburg and return to Trinidad, Mesozoic and Tertiary of the east flank of the Raton basin, *in* Raton basin field trip, Colorado and New Mexico, 1969, Guidebook: Mtn. Geologist, v. 6, no. 3, p. 149-164, illus., 1969.

This road log covers a one-day field trip which begins at Trinidad and trends northwest, then northeast, then southeast, and returns to Trinidad; it is 192 miles long and makes 8 stops. All stops are in Mesozoic rocks and examine various facies and coal beds. Several exposures along the route are mentioned. —HRC

05009 **Mark, Anson; Requist, Norris.** Third day's road log—Walsenburg to Rye to Wetmore, Mesozoic of the Wet Mountains, *in* Raton basin field trip, Colorado and New Mexico, 1969, Guidebook: Mtn. Geologist, v. 6, no. 3, p. 184-190, illus., 1969.

This field trip is one day long, covers 76 miles, and makes 4 stops. Three stops are in Cretaceous rocks, and one is in the Jurassic Morrison Formation. The geology along the way is described also. —HRC

04713 **Marlowe, James I.** A succession of Tertiary strata off Nova Scotia, as determined by dredging: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1077-1094, illus., table, 1969.

Strata from Oligocene to Miocene age occur on the sides of The Gully, a large submarine canyon near Sable Island. The section may be up to 1400 m thick; most is mudstone with minor amounts of sandstones. The section is more coarse and more varied in texture toward the bottom. The sand fraction is quartz-rich and contains minor feldspar and rock fragments. Slight variations in accessory minerals reflect the relative influence of plutonic and metamorphic source rocks. Pyrite suggests a negative Eh. Illite and kaolinite compose most of the clay-size fraction, with lesser amounts of montmorillonite. Continuous-seismic reflection surveys show that subbottom reflectors dip gently seaward. Petrological, structural, and faunal data indicate that the section is part of the Atlantic Coastal Plain. —*from* Author's abstract

04490 **Marr, John W.** Cyclical change in a patterned-ground ecosystem, Thule, Greenland [with French abs.], *in* The periglacial environment, past and present (T. L. Péwé, editor)—Internat. Assoc. Quaternary Research, 7th Cong., Alaska, 1965: Montreal, Quebec, McGill-Queen's Univ. Press, p. 177-201, illus., tables, 1969.

Fine particles in a bouldery matrix form islands along the South River; some are plugs of fines rising from the permafrost table. Islands range in size from 0.1 to 80 m^2; larger debris islands form by the accretion of basic units. Vegetation changes permit arranging the islands in a dynamic sequence, the pioneer plants being moss-lichens and the climax being heather. The ground cracks and disintegration begins, the substratum becomes concave, plant species change and eventually are blown away, leaving lichen-poor gravel and cobbles in a matrix of lichen-rich boulders. This cyclical process proceeds while the regional environment is relatively stable, and is a product of the internal ecosystem processes. The building may result from ice formation in the active layer, and the destruction may come from melting brought on by the dark plant cover. —*from* Author's abstract

Martinez, S. J. *See* Graves, Roy W. 04791

04376 **Mason, I. M.** Metasomatic aureole of the Whitestone anorthosite [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 140, 1969.

04447 **Mason, Warren P.** Internal friction mechanism that produces an attenuation in the Earth's crust proportional to the frequency: Jour. Geophys. Research, v. 74, no. 20, p. 4963-4966, illus., 1969.

To explain an attenuation proportional to the frequency (internal friction Q^{-1} independent of the frequency) present for waves in the Earth's crust, a nonlinear mechanism connected with the motion of dislocations is proposed. With the kink model for dislocation motion, it is shown that an energy loss occurs when the kink goes over the kink barrier and becomes unstable. This loss is proportional to the number of kink displacements, and for a given strain level the number of kink displacements per cycle, i.e. the Q^{-1} value, will be independent of the frequency. The energy loss measured is consistent with theoretical calculations of the dissipation stress, and the loop length l_A and the number of dislocations found are consistent with the results for polycrystalline metals and rocks. —Author's abstract

04437 **Mather, Bryant.** Pozzolan, *in* Reviews in engineering geology, V. 2 (D. J. Varnes and George Kiersch, editors): Boulder, Colo., Geol. Soc. America, p. 105-118, 1969.

Pozzolans include natural materials such as some type of volcanic tuff, opaline chert, shale, or calcined clay, and artificial materials such as precipitated silica and some types of fly ash. Pozzolans are used mainly as admixtures in portland-cement concrete, particularly in massive structures, in proportions ranging from five percent to more than the amount of portland cement. —*from* Author's abstract

04782 **Mathieu, P. G.; Rice, G. W.** Multivariate analysis used in the detection of stratigraphic anomalies from seismic data: Geophysics, v. 34, no. 4, p. 507-515, illus., tables, 1969.

Differentiating stratigraphic conditions from a single variable, for example time interval or amplitude is often very difficult. A linear combination of a large number of variables can in many cases uniquely describe a specific stratigraphic condition. It is shown how this technique, known as discriminatory analysis, can be used effectively with seismic data and an example is given in which it successfully delineated a known oil-bearing sand body directly from seismic traces. —GV

04436 **Matthews, R. K.** The coral cap of Barbados—Pleistocene studies of possible significance to petroleum geology, *in* Cyclic sedimentation in the Permian Basis—Symposium, Midland, Tex., 1967: West Texas Geol. Soc. Pub. 69-56, p. 28-40, illus., 1969.

Radiometric dating of various elevated reef tracts (Th-230 age determination of from 80,000 to 340,000 yr B.P. on various reefs) provides the most convincing evidence that Pleistocene sea-level fluctuations are in part ascribable to climatic variation resulting from the systematic perturbations of the Earth's orbit. The Pleistocene record on Barbados provides some insight as to how coral reefs and reef associated facies react to cyclic eustatic sea level fluctuations. Importance of sediment production rather than coral ecology is emphasized. Diagenetic modification of the reefs and associated sediments is systematic and closely related to variations in post-depositional environment attendant to cyclic fluctuations in sea level and more gradual uplift of the island. —KAF

04962 **Matuszczak, R. A.** Trinidad Sandstone interpreted, evaluated, in Raton basin, Colorado-New Mexico, *in* Raton basin field trip, Colorado and New Mexico, 1969, Guidebook: Mtn. Geologist, v. 6, no. 3, p. 119-124, illus., 1969.

The Trinidad Sandstone was deposited as a complex of beach, nearshore and offshore sand bodies by a regressive Cretaceous sea; occasional transgressions occurred and resulted in considerable thickening and winnowing of the sand deposits. Outcrop data can be projected into trends by use of local sedimentary features and

limited subsurface control. Combinations of subsurface and surface data allow a preliminary attempt to establish trends of thickest, most porous sandstones. The oil and gas potential of the Trinidad Sandstone is analogous to the depositionally and temporally similar Pictured Cliffs Sandstone of the San Juan basin. —*from* Author's abstract

Matzat, E. *See* Mandarino, J. A. 04375

Mayeda, Toshiko K. *See* Tarutani, Toshikazu. 04544

Mayo, Lawrence R. *See* Plafker, George. 04454

Mays, R. E. *See* Dodge, F. C. W. 05002

04680 **McAllister, D. E.; Harington, C. R.** Pleistocene grayling, *Thymallus*, from Yukon, Canada: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1185-1190. illus., table, 1969.

Eleven cycloid fish scales or scale fragments with scalloped anterior margins were obtained from a Pleistocene deposit in the Old Crow area, Yukon Territory. Shells from the same horizon as the scales were radiocarbon dated at 32,400 ± 770 yr B. P. The scales are from the Arctic grayling, *Thymallus arcticus*, providing the first fossil records of the genus and of the subfamily Thymallinae for North America.—Authors' abstract

04486 **McBride, Earle F.** Stratigraphy and sedimentology of the Dagger Flat Sandstone, *in* A guidebook to the stratigraphy, sedimentary structures and origin of flysch and pre-flysch rocks of the Marathon basin, Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 29-31, illus., 1969.

This Late Cambrian formation is the oldest in the Marathon basin. The base is not exposed, and structural complexity makes stratigraphic interpretation difficult. Two members are recognized. Sedimentary petrologic details are discussed; most of the rocks are flysch-like interbedded shale and sandstone (including calcarenite) beds. Sole marks and a common upward sequence of internal structures typical of deposition from waning currents are present also. Deposition was probably in quiet, deep water. The sandstones and calcarenites are probably turbidites because they are graded and lack internal fabric associated with facies of tidal channel deposits. Directional sole marks suggest currents in all directions except toward the northeast. The major source of the sediments was a sedimentary-rock terrane with granitic rocks a minor source; trace amounts are from other terranes. —HRC

04530 **McBride, Earle F.** Stratigraphy and sedimentology of the Fort Peña Formation, *in* A guidebook to the stratigraphy, sedimentary structures and origin of flysch and pre-flysch rocks of the Marathon basin, Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 43-46, illus, 1969.

The formation is Middle Ordovician in age and consists of interbedded shale, calcarenite, conglomerate, chert, and boulder beds. The boulder beds have an unknown geometry and are in the lower part of the formation. The calcarenite beds have a wide range of composition including chiefly micrite clasts, oolites, and skeletal grains. Chert occurs as thin beds devoid of carbonate, as chertified fine-grained tops of graded calcarenites, and as lenses and pods in the calcarenite beds. The formation was deposited in deep water, the shallow-water features being only in current-deposited beds, and so brought into deeper water. The boulder beds may be submarine slides. A progressive deepening of the geosyncline during deposition or an advance of the facies to a more distal position is suggested. —HRC

04531 **McBride, Earle F.** Sedimentology of the Woods Hollow Shale, *in* A guidebook to the stratigraphy, sedimentary structures and origin of flysch and pre-flysch rocks of the Marathon basin, Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 47-51, illus., 1969.

The formation is predominantly a shale, between 400 and 500 feet thick. The shale is intensely bioturbated, but only graptolite remains are found. Numerous siltstone, sandstone, and calcarenite beds are interspersed, all of which show structures from deposition by waning currents and are probably turbidites; graded bedding is present but obscure, and current ripple marks are well formed. The clastic beds have a wide range of composition. Paleocurrents flowed to the southwest, essentially parallel with the bathymetric axis. Boulder-bearing shale and mudstone lenses occur locally. A deep water origin is based on the general lithology, broad extent of the lithosomes, and absence of exclusively shallow water phenomena. —HRC

04532 **McBride, Earle F.** Stratigraphy and sedimentology of the Maravillas Formation, *in* A guidebook to the stratigraphy, sedimentary structures and origin of flysch and pre-flysch rocks of the Marathon basin, Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 52-57, illus., 1969.

Three informal members can be recognized throughout the basin: limestone and chert, black chert and limestone, and chert and shale; the latter is very thin. The lower unit is coarse to fine-grained arenite in 4-16 inch beds. Chert beds and lenticular conglomerates are locally present; the conglomerate contains older basin and contemporaneous materials. The middle member is 40-90 percent chert in beds 6-18 inches thick. The beds are from deep water deposition in a reducing environment as shown by the great extent of the formation, the absence of exclusively shallow-water structures, the absence of benthonic organisms in place, the presence of burrows only along bedding planes, the abundance of organic material, and the predominance of graded bedding. —HRC

04533 **McBride, Earle F.; Thomson, Alan.** Stratigraphy and origin of the Caballos Novaculite, *in* A guidebook to the stratigraphy, sedimentary structures and origin of flysch and pre-flysch rocks of the Marathon basin, Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 58-65, illus., 1969.

The novaculite is chiefly a white chert but contains some off color cherts and lesser colored shales. It is composed of five informally recognized units, each of which is distinctive in the center of the basin but not along the edges; fossils indicate it is Devonian in age. The novaculite is a product of the recrystallization and opalization of radiolarian and spiculiferous beds in a basin which was receiving very little terrigenous material. The nonwhite cherts owe their color to minor amounts of impurities which entered the basin from time to time. A few calcarenite beds are composed of graded skeletal grains with minor quartz, chert, and feldspar. Conodonts are the only fossils present. The formation is a deep water deposit in a starved basin. Contact relations suggest continuous deposition for over 80 m.y. —HRC

04537 **McBride, Earle F.** Stratigraphy and sedimentology of the Haymond Formation, *in* A guidebook to the stratigraphy, sedimentary structures and origin of flysch and pre-flysch rocks of the Marathon basin, Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 86-92, illus., 1969.

The formation is a monotonous sequence of thin, fine-grained sandstone layers interbedded in shale, 1400 m thick. An interval of mudstone and contorted flysch beds which contains exotic and erratic boulders is associated with coarse-grained generally thick sandstones. The boulders contain Pennsylvanian fossils, and only plants and traces are indigenous to the Haymond. Marine Pennsylvanian fossils are in the uppermost layers which are transitional to the overlying formation, and Atokan fusulinids occur near the base. The flysch facies are from slowly accumulating mud deposits in a deep basin in which turbidity currents periodically deposited sand beds. The boulder beds are from submarine slumps. The paleoslope dipped west, judging by the paleocurrent indicators above and below the boulder beds, the source of which must have been in the east. —HRC

McBride, Earle F. *See* Dallas Geological Society. 04540

04541 **McBride, Earle F.; Thomson, Alan.** (leaders). Introduction [and] field trip stops, *in* A guidebook to the stratigraphy, sedimentary structures and origin of flysch and pre-

flysch rocks of the Marathon basin, Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 1-22, illus., 1969.

An unbroken sequence of over 16,000 feet of Late Cambrian to Late Pennsylvanian sedimentary rocks are present in the Marathon geosyncline. The first stage of the geosyncline is characterized by subsidence greater than infilling; the second stage has a high rate of infilling, and it is this sequence that is investigated on the trip. Nine stops are made on a two-day trip to illustrate the rock types in the geosyncline. Each stop is described in detail but no mileage nor geological information between stops are given. —HRC

04710 **McCaleb, J. A.; Wayhan, D. A.** Geologic reservoir analysis, Mississippian Madison Formation, Elk Basin Field, Wyoming-Montana: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 10, pt. 1, p. 2094-2113, illus., tables, 1969.

Oil production from the Mississippian Madison Group is now more than 75 million bbl from 5,100 acres; productive closure is about 1,400 feet. The Madison carbonate sequence has been greatly altered by ground-water erosion. The overall effect of karst activity was the collapse of sections of the upper Madison, up to 300 feet thick, into brecciated rubble zones. Areas of remineralization have produced relatively impermeable zones that form stratigraphic traps. Ground-water action removed the more soluble limestone but left the less soluble dolomite, forming good secondary porosity. From these variations a multiple working hypothesis can be developed for reservoir engineering analysis. The overall hypothesis provides a good vertical and areal model of the reservoir. Practical application of the hypothesis has resulted in a dramatic production response. —*from* Authors' abstract

04776 **McCarren, Edward F.; Keighton, Walter B.** Water quality and discharge of streams in the Lehigh River basin, Pennsylvania: U.S. Geol. Survey Water-Supply Paper 1879-H, p. H1-H48, illus., tables, 1969.

The Lehigh River, 100 miles long, drains four physiographic provinces. Its headwaters, in the mountainous, forested and swampy areas of the Appalachian Plateaus, are of good quality. Downstream, in the Valley and Ridge, New England, and Piedmont provinces, with broad agricultural valleys and areas of urban and industrial development, some streams become acidic from coal-mine drainage; others, fed by alkaline ground water from limestone bedrock, can neutralize and dilute some of the acid mine water where they mix. In shallow reaches rapid aeration increases the oxygen content; most of the river water requires only moderate treatment for industrial and public use. Damage to quality by pollution is more extensive and prolonged during periods of low flow. Comparative tables give values of physical and chemical properties measured over periods of time, some as far back as 1944; graphs show relative curves. —GDC

04955 **McCarthy, J. H., Jr.; Gott, Garland B.; Vaughn, W. W.** Distribution and abundance of mercury and other trace elements in several base- and precious-metal mining districts, *in* Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, p. 99-108, illus., table, 1969.

The distribution of mercury in soils, compared with the distribution of other elements, in four base- and precious-metal mining districts is shown. The two base-metal deposits are Ely, Nevada, and the Park City, Utah, districts. The two precious-metal deposits are Cripple Creek and Lenado, Colo. Mercury is more abundant in the rocks and soils of the base-metal deposits than in the other two; mercury anomalies reflect the known mineral deposits in all districts, and might be used to indicate the presence of concealed mineral deposits and perhaps even their depths. The apparatus for measuring Hg in soil and gas is described. —HRC

McCarthy, J. Howard, Jr. *See* Gott, Garland B. 04453

04575 **McCormick, J. Edward; Evans, Lanny L.; Palmer, Raleigh A.; Rasnick, Frank D.** Environment of the zinc deposits of the Mascot-Jefferson district, Tennessee [abs.]: Econ. Geology, v. 64, no. 3, p. 353, 1969.

McCrady, A. D. *See* Guilday, J. E. 04939

04711 **McCubbin, Donald G.** Cretaceous strike-valley sandstone reservoirs, northwestern New Mexico: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 10, pt. 1, p. 2114-2140, illus., tables, 1969.

Cretaceous "Gallup" fields in the San Juan basin are stratigraphically controlled oil accumulations in marine sandstone deposited during a transgression over the pre-Niobrara erosion surface. The paleotopography of the erosion surface consisted of northwest-trending cuesta-like ridges and intervening valleys with the steeper slopes facing northeast. The ridges were resistant beds in the folded pre-Niobrara sequence. Local relief was more than 100 feet. Individual sandstone bodies in the overstepping sequence are localized on the seaward side of cuesta faces and successively younger sandstone beds extend farther in the direction of transgression. The sands, transported along shore from beyond the area, were deposited in significant thicknesses where the advance of the sea was slowed by the increase in slope associated with the ridges. —EAM

McDougal, Samuel E. *See* Fulweiler, Robert E. 04584

04648 **McGetchin, Thomas Richard.** The Moses Rock dike—Geology, petrology and mode of emplacement of a kimberlite-bearing breccia dike, San Juan County, Utah [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 259B, 1969.

05004 **McGlasson, Ed H.** Siluro-Devonian of west Texas and southeastern New Mexico, *in* Border stratigraphy symposium—AAAS S.W. and Rocky Mtn. Div., 44th Ann. Mtg., El Paso, Tex., 1968: New Mexico Bur. Mines and Mineral Resources Circ. 104, p. 26-37, illus., 1969.

Rocks of Silurian and Devonian age are known in three areas in west Texas. These are the Marathon and Solitario uplifts, the subsurface Tobosa basin, and the outcrops in the Franklin, Hueco, and Sierra Diablo Mountains. The names and correlation of the rock units of these three areas are shown. The rocks were deposited in an Early and Middle Paleozoic depositional basin called the Tobosa basin (Galley, 1958) and in the adjoining Marathon-Ouachita geosyncline. Four columnar sections are typical of the four areas in which they are located. Correlation between these areas has been difficult, but detailed studies have shown that they contain different facies of equivalent rock units. —*from* Author's abstract

McGrain, Preston. *See* Dever, Garland R., Jr. 04659

McHugh, John B. *See* Gott, Garland B. 04453

04649 **McKenzie, Garry Donald.** Glacial history of Adams Inlet, southeastern Alaska [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 260B, 1969.

04665 **McKinney, Frank K.** Bibliography and list (1900-1965) of the families Constellariidae and Dianulitidae (Ectroprocta, order Cystoporata): Southeastern Geology, v. 10, no. 3, p. 175-184, 1969.

The small bibliography and taxonomic list presented here is intended as a supplement to "A synopsis of American fossil Bryozoa. . ." (Nickles and Bassler, 1900, U.S. Geol. Survey Bull. 173), which was restricted to North American ectoprocts. The present compilation is from worldwide literature on Paleozoic ectoproct families. Textbooks and stratigraphic lists are not included. Family-group taxa are listed separately from genus- and species-group taxa. A larger bibliography and list of Trepostomata for the years 1900-1964 is to be published later. —GDC

McKown, D. M. *See* Ehmann, W. D. 04636

04423 **McManus, Dean A.; Kelley, James C.; Creager, Joe S.** Continental shelf sedimentation in an arctic environment: Geol. Soc. America Bull., v. 80, no. 10, p. 1961-1983, illus., tables, 1969.

A factor analysis of 579 sediment samples from the Chukchi and northeastern Bering Seas identified three factors that "explain" 92 percent of the variation of ten granulometric variables: (I) represents deposition of mud by settling; (II) represents both the provenance of the sand and its deposition or modification by nearshore processes; and (III) represents beach and other processes producing poorly sorted sediment. Factor I is the most widely distributed. Mud from the Yukon River covers the bottom of Norton Sound and is encroaching onto relict sands in the Chirikov Basin; with mud from other Alaskan rivers, it is also reaching the Chukchi Sea. The nearshore sands of the southeastern Chukchi Sea are modern; elsewhere they are relict. —ATO

04673 **McManus, Dean A.; Morrison, Douglas R.** Quinn Guyot (Ga-3) not tilted toward Aleutian Trench: Marine Geology, v. 7, no. 4, p. 365-368, illus., 1969.

A recent survey of Quinn Guyot in the Gulf of Alaska using modern equipment [Loran, computerized dead reckoning, and GDR-T recorder] shows that the guyot is not tilted toward the Aleutian Trench as previously thought. Its morphology, therefore, may reflect the vertical movements of the East Pacific Rise, but the guyot no longer should be noted as an example of downflexing of the sea floor during subsidence of the trench. —Authors' abstract

McNeill, R. L. *See* Caudle, W. N. 04950

McNutt, R. H. *See* Kretschmar, U. H. 04372

Mebane, William M. *See* Vozoff, Keeva. 04903

Megaw, Helen D. *See* Ribbe, P. H. 04904

04846 **Mehnert, K. R.** Composition and abundance of common metamorphic rock types, Chap. 9 *in* Handbook of geochemistry, V. 1 (K. H. Wedepohl, editor): Berlin and New York, Springer-Verlag, p. 272-296, illus., tables, 1969.

General trends in metamorphism and the processes and products of isochemical, allochemical, and contact metamorphism are discussed in terms of defining metamorphic rock types. Discussion of the concepts of mineral facies, anatexis, and granitization is included, as well as tabulated chemical and mineralogic data. Among various conclusions it is noted that contact metamorphism is controlled by the same geochemical principles as regional metamorphism and that there are three possible modes of origin of granites (magmatic, anatectic, metasomatic), all of which may be represented within a single massif. —MS

Mehrotra, Bharati. *See* Dilcher, David L. 04700

04480 **Meissner, Fred F.** Cyclic sedimentation in Middle Permian strata of the Permian Basin, west Texas and New Mexico[abs.], *in* Cyclic sedimentation in the Permian Basin—Symposium, Midland, Tex., 1967: West Texas Geol. Soc. Pub. 69-56, p. 135, 1969.

04444 **Menard, H. W.** Growth of drifting volcanoes: Jour. Geophys. Research, v. 74, no. 20, p. 4827-4837, illus., table, 1969.

Volcanic seamounts that increase in size with distance from a midocean ridge crest may remain active as they drift with the crust. Hardly any volcanic islands rise above the oceanic crust produced during the last 10 m.y. by sea-floor spreading. Ocean basin volcanoes commonly remain active for tens of millions of years. The paleobathymetry of the Darwin rise is compatible with sea-floor spreading. The discharge of lava in the Hawaiian Islands in historical times has been many times greater than average for an equivalent length of midocean ridge crest. These volcanoes in the center of the Pacific tectonic plate grow rapidly with minimum drifting before they reach the surface. Smaller volcanoes in the basin thus may be built in a single magnetic polarity period, as suggested by paleomagnetism. —*from* Author's abstract

04993 **Menard, H. W.** The deep-ocean floor: Sci. American, v. 221, no. 3, p. 127-142, illus., 1969.

The deep-ocean floor is growing outward from mid-ocean ridges. This discovery fostered the concept of plate tectonics. Leading edges of the huge plates are invariably significantly lower than the mid-ocean ridges suggesting that, following solidification, the plates gradually sink. Various rates of spreading combined with the rate of sinking and the interaction of two or more plates may explain many tectonic features of continents as well as ocean basins. —DWR

04733 **Mendes, R. V.; Miesch, A. T.; VanTrump, George, Jr.** Computer management of geochemical data [abs.]: Mining Eng., v. 21, no. 8, p. 43, 1969.

04586 **Merino y Coronado, José.** Resumen de las observaciones hechas sobre la receinte erupción del volcán el Arenal: Costa Rica Inst. Geog. Nac. Informe Semestral July-Dec. 1968, p. 13-17, 1969.

Arenal Volcano began a period of violent eruption on July 29, 1968. Although there is no historical record of such violent activity, two or three fumaroles emitting toxic gases at high temperature have been active in the crater for the past 30 years at least. The July eruption was of "Peléen" type and its paroxysmal explosions were accompanied by at least two "nuees ardentes" which caused great destruction. An intensive study of the area of the volcano is recommended including establishment of a central organization in Costa Rica for monitoring and studying all volcanoes. —VSN

04655 **Merritt, Donald Warren.** A gravitational investigation of the Scipio oil field in Hillsdale County, Michigan, with a related study for obtaining a variable elevation factor [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 263B, 1969.

04650 **Mesolella, Kenneth Joseph.** The uplifted reefs of Barbados—Physical stratigraphy, facies relationships and absolute chronology [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 260B-261B, 1969.

Messina, Angelina R. *See* Ellis, Brooks F. 04582

04801 **Meyboom, P.** Some aspects of the scientific communication system in hydrology: Ground Water, v. 7, no. 4, p. 28-37, illus., tables, 1969.

This paper deals successively with some general concepts of scientific communication, with the characteristics of four well-known hydrology journals and with ways in which messages are obtained. The most important conclusion is a rationale for restrained publication. —Author's abstract

Meyers, T. Ralph. *See* Novotny, Robert F. 04763

04637 **Michelsen, O. B.; Steinnes, E.** Determination of some rare earths in rocks and minerals by neutron activation and gamma-gamma coincidence spectrometry, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 315-319, table, 1969.

Gamma-gamma coincidence measurements of the 9.3 h Eu-152m resulting from neutron activation is a convenient method for determination of Eu in large series of rock samples. Techniques are discussed and some determinations of Eu made on test samples of three apatites and one iron ore are tabulated. Preliminary experiments on determination of La, Sm, Tb, Yb, and Lu are described briefly. —VSN

Miesch, A. T. *See* Mendes, R. V. 04733

Miles, N. *See* Hogarth, D. D. 04387

04613 **Millard, H. T., Jr.** Neutron activation analysis of individual cosmic spherules, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 395-398, table, 1969.

A 1.5 ton sample of Pacific Ocean sediment was processed to isolate cosmic spherules; the 150 to 350 micron diameter spherules were studied by neutron activation analysis. Concentrations of Ni, Co, Mn, and Ir measured are tabulated. Data were normalized to concentration of iron in each sample to reconstruct the unoxidized composition of the spherules and facilitate comparison with data in the literature for meteorites and terrestrial materials. Ni/Fe and Co/Fe ratios do not vary by more than a factor of 10 among spherules studied; Mn/Fe ratios vary by a factor of at least 1000. Ir concentration, where measured, is about 1000 times that expected in terrestrial materials. Spherules fall into two groups: low Mn, high Ir, and high specific gravity and (2) high Mn, probably low Ir, and low specific gravity. The first group must be from iron meteorites and the second are probably terrestrial. —VSN

04827 **Miller, C. Daniel.** Chronology of neoglacial moraines in the Dome Peak area, North Cascade Range, Washington: Arctic and Alpine Research, v. 1, no. 1, p. 49-65, illus., tables, 1969.

The earliest recognized ice advance was that of South Cascade glacier about 4,900 years ago. South Cascade, Dana, and Le Conte glaciers reached their neoglacial maxima in the 16th century and built moraines in the 19th and 20th centuries. Chickamin glacier reached its neoglacial maximum in the 13th century and built several moraines between the 16th and 20th centuries. The anomaly may be due to steeper profile and higher accumulation for Chickamin than the others. Fluctuations in the Dome Peak area during the latter neoglacial are broadly synchronous with those elsewhere in the Pacific Northwest. The neoglacial record is incomplete, however, inasmuch as no evidence for an earlier expansion about 2800-2600 years ago was found, which is well documented in other places in western North America. —*from* Author's abstract

04438 **Miller, Maynard M.** The Alaskan Glacier Commemorative Project, Phase 1, *in* National Geographic Society research reports 1964 (Paul H. Oehser, editor): Washington, D.C., Natl. Geog. Soc., p. 135-152, illus., 1969.

A regional survey of glaciers in southern Alaska is underway, with particular reference to effects of the Good Friday earthquake of 1964. The program to date has involved ground studies, phototheodolitic surveys, and aerial photography. Subaerial denudation has caused many debris-avalanches in the area outside of the earthquake-affected zone, the Taku-Llewellyn glacier being most intensely studied. Geomorphic, pedological, and geobotanical studies of icefield nunataks and Little Ice Age moraines have also been made. In the Nunatak fjord area and in Yakutat Bay, earthquake effects on glaciers were studied. The most extensive earthquake effects were found in the Copper River region, where several hundred significant earthquake-induced avalanches were noted. Others were seen in the Prince William Sound. Surging of the glaciers is noted also. —HRC

Miller, W. W. *See* Pillay, K. K. S. 04693

04452 **Minard, James P.** Geology of the Sandy Hook quadrangle in Monmouth County, New Jersey: U.S. Geol. Survey Bull. 1276, 43 p., illus., table, geol. map, 1969.

The Sandy Hook area contains the thickest and most complete exposed section of Upper Cretaceous sediments (11 units altogether) in the New Jersey Coastal Plain. Seven of these units as well as three Tertiary units, totaling 500 feet of section, are well exposed in the Sandy Hook quadrangle. These units are the result of repetitive sedimentation in which one complete cycle consists of a glauconite unit, overlain by a fine sandy silt unit, overlain by a coarse sand unit. The formations consist chiefly of quartz, glauconite, mica, clay, lignite, pyrite, and ilmenite. The formations strike generally northeast, and dip southeast at about 10 to 40 feet per mile. Sandy Hook is a classic example of an active compound, recurved spit. —JPM

04688 **Miyashiro, Akiho; Shido, Fumiko; Ewing, Maurice.** Composition and origin of serpentinites from the Mid-Atlantic Ridge near 24° and 30° north latitude: Contr. Mineralogy and Petrology, v. 23, no. 2, p. 117-127, illus., tables, 1969.

Serpentinites in two transverse fracture zones in the Mid-Atlantic Ridge, about 200 km distant from each other, show practically the same trend and range of variation in chemical composition. Serpentinites relatively high in CaO contain pargasite; those relatively low in CaO do not. Those high in CaO are chemically similar to high temperature peridotites which are believed to be from the upper mantle. Other chemical variations may be partly due to heterogeneity of upper mantle peridotite and partly to chemical migration during serpentinization. The interior of the ridge may be made up of serpentinite or the ridge serpentinites may have been formed by serpentinization of peridotites that were intruded into fracture zones from a great depth. —*from* Authors' abstract

04764 **Miyashiro, Akiho; Shido, Fumiko; Ewing, Maurice.** Diversity and origin of abyssal tholeiite from the Mid-Atlantic Ridge near 24° and 30° north latitude: Contr. Mineralogy and Petrology, v. 23, no. 1, p. 38-52, illus., tables, 1969.

Chemical analyses of abyssal tholeiite in a dredge haul show regular variation. The MgO content decreases with increasing SiO_2. In abyssal tholeiites with relatively low Al_2O_3 contents, the SiO_2, total Fe, Na_2O and P_2O_5 contents tend to increase and the MgO to decrease with increasing Fe/Mg ratio. In certain hauls, high Al and low Al tholeiites are associated; this would have differentiated at a depth of around 30 km. In pillow lavas of abyssal tholeiites free from weathering and metamorphism the chilled zone is the same as the core save for a decrease in K_2O toward the rim. Weathered rims, however, show marked compositional changes. The Fe_2O_3/FeO ratio of unweathered abyssal tholeiite is in the range of 0.1 to 0.3. This ratio and the H_2O^- and H_2O^+ contents increase with advance weathering. —*from* Authors' abstract

Moller, J. *See* Dansgaard, W. 04852

04818 **Monger, J. W. H.** Stratigraphy and structure of upper Paleozoic rocks, northeast Dease Lake map-area, British Columbia (104J): Canada Geol. Survey Paper 68-48, 41 p., illus., tables, geol. map, 1969.

Upper Paleozoic rocks of the Cache Creek Group in northeastern Dease Lake map-area consist of: basal Kedahda Formation (at least 5,000 feet thick, largely chert and pelite); French Range Formation (3,000 to <1,000 feet of basic flow rocks, intrusive equivalents, and pyroclastic rocks); and Teslin Formation (carbonate with locally abundant algal structures and fusulinids, about 1,500 feet thick). The Teslin ranges in age from Early to Late Permian; its top is not recognized in the map-area, and lower Mesozoic volcanic rocks and sandstones are in fault-contact with older rocks. Upper Paleozoic rocks appear to have undergone two phases of deformation: early, probably isoclinal recumbent folding and low-grade regional metamorphism; and later, affecting both late Paleozoic and Mesozoic rocks and largely responsible for present map patterns. —*from* Author's abstract

04502 **Moore, C. H., Jr.; Boutté, A. L.; Marcantel, E. L.; Marcantel, J. B.** Road logs, *in* A guidebook to the depositional environments and depositional history, Lower Cretaceous shallow shelf carbonate sequence, west-central Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 105-135, illus., 1969.

The field trip is three days long. The first day, starting at Abilene, is 125 miles long, and makes five stops. Each is discussed in detail in the guide, with a brief description of the geology enroute. The second day trip starts in Abilene and continues to Sweetwater, and then back to Abilene. It is 116 miles long and makes four stops. The third day begins and ends in Robert Lee. It is 92 miles long and makes two stops. All of the stops are in Cretaceous rocks and show different aspects of the facies of the Fredericksburg sequence; the interpretations of the different facies are discussed at each of the stops. —HRC

04525 **Moore, C. H., Jr.** Stratigraphic framework, Lower Cretaceous, west-central Texas, *in* A guidebook to the depositional environments and depositional history, Lower Cretaceous shallow shelf carbonate sequence, west-central Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 1-16, illus., modified 1969.

The physical stratigraphic framework and basic geologic setting of the Fredericksburg carbonate sequence have the following salient features: (1) The Antlers Sandstone, laterally equivalent to both Fredericksburg and Trinity sands and carbonates, underlies a major part of west-central Texas. (2) The Walnut and Comanche Peak Formations of the Lampassas Cut Plains can be projected into the carbonate sequence exposed on the Callahan divide. The term Walnut Creek-Comanche should not be used south of a line running NW-SE through Sweetwater. (3) The term Edwards Formation can be used throughout the west-central Texas region, and (4) The unnamed formation of Lozo and Smith has been extended northward from the southern Edwards Plateau to the Callahan divide. —*from* Author's summary

Moore, Clyde H., Jr. *See* Dallas Geological Society. 04524

Moore, D. G. *See* Heinrich, E. W. 04393

04408 **Moore, J. M., Jr.; Kranck, S. H.; Chao, G. Y.** Optical and X-ray data for iron-rich orthopyroxenes from northern Quebec: Canadian Mineralogist, v. 10, pt. 1, p. 101-103, tables, 1969.

Several iron-rich orthopyroxenes and two metamorphic bronzites from the metamorphic iron formation of the Mount Reed area, Quebec, have been studied optically and by X-ray diffraction. Results are tabulated and techniques of measurement are reviewed briefly. —VSN

04455 **Moore, James G.; Koyanagi, Robert Y.** The October 1963 eruption of Kilauea Volcano, Hawaii: U.S. Geol. Survey Prof. Paper 614-C, p. C1-C13, illus., tables, geol. map, 1969.

The eruption of October 5-6, 1963, occurred along an 8-mi section of the central part of the east rift zone of Kilauea. About 9 million cu yd of lava, erupted from more than 30 fissures, covered an area of 1.3 sq mi. A few hours prior to the outbreak, the summit began to subside, and strong harmonic tremor and earthquakes commenced at the summit and at the site of later activity near Napau Crater—phenomena apparently caused by subsurface flow of magma from the summit reservoir through the rift zone conduits to eruptive vents 8 mi distant. Eruption lava is a tholeiitic basalt with an average of 5.6 percent olivine; in general, lavas erupted toward the eastern end of the zone are richer in olivine. When compared with lavas that erupted from the summit, these lavas show a slight differentiation apparently caused by cooling and crystallization within the rift zone. —*from* Authors' abstract

Moore, James G. *See* Aramaki, Shigeo. 04669

Moore, John M., Jr. *See* Fox, Peter E. 04682

04466 **Moore, Theodore C., Jr.** Radiolaria—Change in skeletal weight and resistance to solution: Geol. Soc. America Bull., v. 80, no. 10, p. 2103-2107, illus., table, 1969.

During the Cenozoic Era, Radiolaria living in tropical waters developed progressively lighter skeletons, apparently as a result of an evolutionary trend. The average skeletal weight of Quaternary Radiolaria is one-fourth that of Eocene Radiolaria. If the rate of production of these organisms has remained constant, amount of silica delivered to the ocean floor per unit time by Eocene Radiolaria is four times greater than that being deposited by Quaternary Radiolaria. Species from various Cenozoic faunas differ in their resistance to solution. Thus, in assemblages from sediment samples, the presence, absence, and abundance of certain species provide a key to the amount of mixing of faunas and the degree of corrosion of assemblages. —Author's abstract

Moorhouse, Douglas C. *See* Greer, David M. 04889

Moraski, L. K. *See* Johnson, S. W. 04516

Morey, G. B. *See* Griffin, W. L. 04593

Morey, G. B. *See* Sims, P. K. 04850

04780 **Morgan, Nabil A.** Physical properties of marine sediments as related to seismic velocities: Geophysics, v. 34, no. 4, p. 529-545, illus., tables, 1969.

The dependence of seismic velocities on different physical properties of naturally occurring fresh-water sediments in Lake Erie has been investigated. Cores from one lake bottom were collected and the longitudinal seismic wave velocities as well as the physical properties were measured. The data were fitted with a second-order polynomial in all the physical properties to the seismic velocity. Independent variables were ranked according to their individual effect upon the sum of the squares of the regression residuals. Coefficients tests, porosity, and bulk density are discussed. —GV

Morris, Raymond G. *See* Hill, William T. 04585

Morrison, Douglas R. *See* McManus, Dean A. 04673

Morrison, G. H. *See* Peterson, S. F. 04618

Morrison, G. H. *See* Peterson, S. F. 04716

04377 **Mrose, M. E.; Christian, R. P.** The leadhillite-susannite relation [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 141, 1969.

04964 **Mulford, John W.** Volcano watcher's guide to the Caribbean: Cranbrook Inst. Sci. Bull. 54, 29 p., illus., 1969.

The preface by W. H. Parsons to this popular account describes Caribbean volcanoes which are mainly the Peléan type (although some are Vulcanian and Strombolian), *nuée ardente* deposits, and fumaroles. In addition to an introduction, glossary of terms, and bibliography by the author, the following islands and their volcanoes are described: Saba, St. Eustatius, St. Kitts, Nevis, Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, and St. Vincent. —MCM

Müller, F. *See* Ommanney, C. S. L. 04504

Muller, J. E. *See* Hughes, O. L. 04973

04651 **Myers, Paul Edward.** The geology of the Harpster quadrangle and vicinity, Idaho [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 261B, 1969.

04378 **Naldrett, A. J.; Graterol, M.** The mineralogy of the Marbridge No. 3 and No. 4 nickel-iron sulfide deposits [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 141, 1969.

05000 **Naldrett, A. J.** A portion of the system Fe-S-O between 900 and 1080°C and its application to sulfide ore magmas: Jour. Petrology, v. 10, no. 2, p. 171-201, illus., tables, 1969.

Results of experimental investigations of melting relations in the portion of the Fe-S-O system including pyrrhotite, wustite, magnetite, and iron are reported and their geologic implications are discussed with reference to factors controlling bulk composition of a sulfide-oxide liquid as it settles through a silicate magma. Discounting effects of other elements, the minimum temperature of introduction of magmatic sulfide ores ranges between 1010°C and 1050°C. Although substitution of up to 20 percent Ni has little effect on the minimum possible temperature, 2 percent Cu substituting for Fe lowers the minimum by 15° to 20°; water has no apparent fluxing effect. Bulk composition of ore liquid is a function of oxygen and sulfur fugacities of the host silicate magma. Textures of Sudbury nickel ores are among examples cited in support of postulated crystallization trends of the liquids. —MS

04611 **Nave, Floyd Roger.** Pleistocene Mollusca of southwestern Ohio and southeastern Indiana [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 314B-315B, 1969.

Nehru, C. E. *See* Prinz, Martin. 04701

04819 **Neuman, Shlomo P.; Witherspoon, Paul A.** Theory of flow in a confined two aquifer system: Water Resources Research, v. 5, no. 4, p. 803-816, illus., 1969.

A complete analytic solution has been developed for the problem of flow to a well in a confined infinite radial system composed of two aquifers that are separated by an aquitard. The well, which is represented by a line sink, completely penetrates only one of the aquifers and discharges at constant rate. The present solution differs from previous work in that the effects of storage in the aquitard and drawdown in the unpumped aquifer are both considered. Asymptotic solutions for small values of time are also included. The analytic solutions have been evaluated numerically for selected cases. The validity of these solutions has been verified independently using the finite element method of analysis. —Authors' abstract

04983 **Neumann, Else-Ragnhild.** Experimental recrystallization of dolomite and comparison of preferred orientations of calcite and dolomite in deformed rocks: Jour. Geology, v. 77, no. 4, p. 426-438, illus., tables, 1969.

Dover Plains dolomite, Knox dolomite, and Solenhofen limestone were recrystallized under stress and annealed after cold working in a constant strain rate apparatus at 1,000°C and 15 kbar. Dolomite recrystallizes under stress as calcite does, and the new grains have c-axes at small angles to the maximum principal compressive stress. The annealing experiments were inconclusive; however, a weak tendency for c-axes of new grains to lie at 30-60° to c-axes of parent grains was observed. Similarities in behavior of calcite and dolomite in both natural and experimental recrystallization implies that mechanisms of slip and twinning are not responsible for the resultant preferred orientations. The means of recrystallization is not known. —*from* Author's abstract

Niblett, E. R. *See* Caner, B. 04686

04828 **Nichols, Harvey.** The late Quaternary history of vegetation and climate at Porcupine Mountain and Clearwater Bog, Manitoba: Arctic and Alpine Research, v. 1, no. 3, p. 155-167, illus., 1969.

Spruce forest near Porcupine Mountain was replaced by grassland about 6700 B.P., with a maximum of prairie taxa occurring just before 5140 B.P., and a short-lived reduction of grass and herbs shortly thereafter. The grassland ended at 4200 B.P. Rapid *Sphagnum* and increased sporogenesis occurred after 2450 B.P. The 6700-4200 B.P. interval was generally dry, with warm summers; after 4200 the summers were cooler and moister. Clearwater bog is underlain by spruce forest pollen at 1200 B.P., established at an interval of reduced water level. The *Picea* timbers are overlain by very humified peat dated 900 B.P. Unhumified *Sphagnum* then continued on to the present. The summers were warm and dry at 1200-900 B.P.; cooler, wetter summers have characterized the area since then. —*from* Author's abstract

04809 **Nichols, R. A. H.; Wyman, J. M.** Interdigitation versus arbitrary cutoff—Resolution of an Upper Cretaceous stratigraphic problem, western Saskatchewan: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 1880-1893, illus., table, 1969.

The Belly River and Lea Park Formations interfinger in west-central Saskatchewan and east-central Alberta. Previous usage of the formation names obscures relationships of these units because it implies superposition. Confusion also results from time-stratigraphic usage of member names based on a lithologic datum or microfaunal zones. Because the members extend beyond the formations, they are here called tongues, but arbitrary cutoffs which transfer tongues from one formation to another are not used. Tracing of the Ribstone Creek and Victoria Tongues of the Belly River Formation by use of electric logs yields accurate rock-stratigraphic relationships. Gas in the Whiteside gas pool is in the Ribstone Creek Tongue, not the Victoria Tongue. —*from* Authors' abstract

Nickel, E. H. *See* Manning, P. G. 04409

Nickel, E. H. *See* Faye, G. H. 04421

Nooner, D. W. *See* Gelpi, E. 04590

Norris, Dan P. *See* Cotteral, Joseph A. 04890

04763 **Novotny, Robert F.; Meyers, T. Ralph.** (editor). The geology of the seacoast region, New Hampshire: Concord, N.H., New Hampshire Dept. Resources and Econ. Devel., 46 p., illus., tables, geol. map, 1969.

The text of this booklet is derived in part from the manuscript copy of the late Dr. Novotny's doctoral dissertation of 1963, "Bedrock geology of the Dover-Exeter-Portsmouth region"; it represents a complete revision with a minimum of technical terms, to provide a brief summary and review of the geologic materials, processes, structures, and history of this seacoast region. The geologic map, largely the work of Dr. Novotny, was published in 1968. Modal analyses, in appendix, have been taken directly from the dissertation. —GDC

04770 **Nutter, L. J.; Otton, E. G.** Ground-water occurrence in the Maryland Piedmont: Maryland Geol. Survey Rept. Inv. 10, 56 p., illus., tables, 1969.

Factors governing occurrence of ground water in crystalline rocks of the Maryland Piedmont are complex and variable; rocks range in age from Precambrian to early Paleozoic. Much of the stored ground water is in the weathered zone (saprolite), having an average thickness of about 45 feet. Analysis of well yields and specific capacities shows that wells situated in valleys or draws yield three to four times as much water as wells on hilltops or divides. Little significant difference was observed for yield of wells in different rock types, although wells in marble are most productive; mean yield of all wells is about 9 gpm. Ability of crystalline rocks to transmit and store water is shown by aquifer tests to be extremely variable; logs of wells provide a useful means of identifying water-bearing zones and changes in character of rocks. —*from* Authors' abstract

Oeschger, H. *See* Williams, P. M. 04927

04606 **Ogden, James Gordon, 3d.** Wisconsin vegetation and climate of Martha's Vineyard, Massachusetts [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 84B, 1969.

Ogden, Lawrence. *See* Lounsbury, John F. 04773

04924 **Olesen, Ole B.; Reeh, Niels.** Glacier observations in Nordvestfjord, Scoresby Sund district, *in* report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 59-62, illus., table, 1969.

Various measurements are made on Daugaard-Jensen, Charcot, Graah, and Stauning Alper glaciers. The latter is surging. —HRC

04775 **Olle, John M.** Molluscan fauna and lacustrine sediments in Sanpete Valley near Manti, Sanpete County, Utah: Sterkiana, no. 35, p. 5-14, illus., tables, 1969.

A quiet, shallow lake, with a bottom of fine sand, silt, clay, and mud, as determined by the environments of the molluscan faunas as well as by the mechanical analysis of the sediments, was formed as a result of a large bouldery debris flow that came out of Six Mile Canyon and dammed the San Pitch River. The lake formed behind the bouldery dam, thus depositing the 'Gunnison Reservoir Deposit' (Roy, 1962) and the Manti deposit of this report. The similarities of these deposits, similar molluscan fauna and similar elevation, indicate that they are of the same origin. The name Lake Sterling is proposed for this lake. —Author's conclusions

04379 **Olsen, E.; Bunch, T.** A redefinition of the chemical composition of osumilite [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 142, 1969.

04504 **Ommanney, C. S. L.; Goodman, R. H.; Müller, F.** Computer analysis of a glacier inventory of Axel Heiberg Island—Canadian Arctic Archipelago: Internat. Assoc. Sci. Hydrology Bull., v. 14, no. 1, p. 19-28, illus., tables, 1969.

The Commission of Snow and Ice of the I.A.S.H. has prepared guide lines for recording and mapping of worldwide distribution, water equivalent and related data of: total seasonal snow cover; sea, lake and river ice; and perennial ice and snow masses on and beneath land surfaces. Using glacier inventory as an example, problems of standardization and presentation of data are discussed. Operation of a computer program written for a Univac 1108 and use of its 'control' cards for analysis of glacier inventory data from a test (Axel Heiberg Island) are outlined. The program sorts according to characteristics and classification numbers. A range of variables may be chosen and any one variable is averaged, totalled or histogrammed as instructed by the control cards. A brief description of the program is included; development of a second stage is envisaged. —*from* Authors' abstract

O'Neil, James R. *See* Barnes, Ivan. 04422

Onuma, N. *See* Higuchi, H. 04624

04513 **Orange, Arnold S.** Granitic rocks—Properties in situ [discussion of paper by G. Simmons and A. Nur, 1968]: Science, v. 165, no. 3889, p. 202-203, 1969.

The conclusions reached by Simmons and Nur (ibid., v. 162, no. 3855, p. 789-791, 1968) that the inconsistency between values of sound velocity and resistivity of granitic rocks in place and in the laboratory is the absence of small open cracks in nature, may be based on doubtful evidence. The lithology of one of the wells in which their measurements were made is very complex. It is difficult to obtain true resistivity for resistive rocks, especially where a conductive drilling mud was used. Resistivity comparisons are meaningless without a knowledge of how porosity and salinity vary with depth. Fracture porosity, probably prevalent in the upper 5 to 10 km of crust, does not behave like typical crack porosity in the laboratory with respect to resistivity. Finally, their conversion from pressure to depth may be incorrect.—DBV

04715 **Ormiston, Allen R.** A new Lower Devonian rock unit in the Canadian Arctic Islands: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1105-1111, illus., table, 1969.

A thin, shelf-type carbonate unit with an abundant shelly fauna of Lower Devonian age is developed in the vicinity of Drake Bay, northwestern Prince of Wales Island where it rests on a dolomitic western facies of the dominantly clastic Peel Sound Formation. These limestones and shales which contrast in thickness, lithofacies, and biofacies with coeval rocks exposed in the Stuart Bay area of Bathurst Island 190 miles (306 km) to the north, represent a new stratigraphic unit. The lithologic characteristics, stratigraphic relations, fauna, and age of the unit are documented, but no name is proposed because of the incompleteness of the exposure and because a more suitable type section is available. —Author's abstract

Oró, J. *See* Gelpi, E. 04590

Otton, E. G. *See* Nutter, L. J. 04770

04741 **Overton, Harold L.; Timko, Donald J.** The salinity factor—A tectonic stress indicator in marine sands: Oil and Gas Jour., v. 67, no. 40, p. 115-124, illus., table, 1969.

The profile of salinity vs. depth in clean sands has been found to be an excellent indicator of effective confining pressure in shales. This new indicator allows major local tectonic features to be determined from a single well using SP-log measurements. It can be used to determine the location of fault zones, compaction stress changes, abnormal pressures, and permeable sands. —*from* Authors' abstract

04720 **Ovnatanov, S. T.; Tamrazyan, G. P.** Paleostructure and lithologic variation coefficients—Their use in exploration for new oil and gas pools: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 10, pt. 1, p. 2171-2178, illus., tables, 1969.

Numerous producing oil and gas fields still contain substantial undiscovered reserves, mostly in the deepest reservoir beds. The use of variations in lithologic character for paleogeographic and paleostructural analysis provides useful auxiliary methods for

discovering new accumulations in producing regions. The methods are quantitative, but simple in formulation and use. Four coefficients are determined: (1) of lithofacies change (in a single sandstone bed); (2) of individual sandstone bed thickness variation; (3) of sandstone bed frequency; and (4) of maximum hydrocarbon saturation. These calculations provide data on lithologic variability, nature, and extent of sandstone buildups, and location of areas in which buildups are likely to occur. —*from* Authors' abstract

04926 **Owen, Donald E.** The Dakota Sandstone of the eastern San Juan and Chama basins and its possible correlation across the Southern Rocky Mountains, *in* Raton basin field trip, Colorado and New Mexico, 1969, Guidebook: Mtn. Geologist, v. 6, no. 3, p. 87-92, illus., table, 1969.

The Dakota Sandstone occurs east and west of the Southern Rocky Mountains. The Lower Cretaceous-Upper Cretaceous boundary is placed tentatively in the Dakota Sandstone locally. Evidence defining precise time-stratigraphic relationships is scanty. In the Chama basin of New Mexico, the Dakota is subdivided into a fluvial lower sandstone unit, a paludal and fluvial middle shale unit, and a marginal marine upper sandstone unit. A similar three-fold subdivision of the Dakota is present in isolated outcrops in Bernalillo and Santa Fe Counties, New Mexico, and in the basal Cretaceous rock section in the Raton basin. The writer suggests that the similar three-fold subdivisions in the Chama basin, Raton basin, and between these basins may be correlative rock-stratigraphic units. —*from* Author's abstract

04917 **Owens, Frith C.** Guy B. Gierhart (1903-1968): Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 2011, portrait, 1969.

Palmer, Raleigh A. *See* McCormick, J. Edward. 04575

Papezik, V. S. *See* Gibbons, R. V. 04368

04380 **Papezik, V. S.** Proterozoic ignimbrites on the Avalon Peninsula, Newfoundland [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 142-143, 1969.

04627 **Parekh, P. P.; Das, M. Sankar; Athavale, V. T.** Neutron activation method for the isotopic analysis of lead, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 320-326, tables, 1969.

Studies are described that were carried out to evaluate the attainable precision in analysis of the Pb-208/Pb-204 ratio by the neutron activation method for age determination purposes. The overall precision was evaluated with the help of a reference sample; accuracy was evaluated by determining the Pb-208/Pb-204 ratio on interlaboratory standard galena and comparing it with mass spectrometric values reported by different laboratories. Results are tabulated. Precision obtained is poorer by a factor of 2 to 3 as compared with typical values reported by mass spectrometry. However, the method is capable of establishing geologic age patterns. —VSN

Parry, W. T. *See* Beers, Armand. 04732

04908 **Paslay, Paul R.; Weidler, Jay B.** Analysis of triaxial test for granular soils: Am. Soc. Civil Engineers Proc., v. 95, paper 6611, Jour. Eng. Mechanics Div., no. EM3, p. 587-609, illus., 1969.

Based on an earlier analytic formulation for the isothermal flow of an idealized cohesionless soil, several implications are deduced for the triaxial test (compression test in presence of hydrostatic pressure). A specific form for the loading surface and the flow rule are selected. Since normality is generally absent uniqueness is not expected and a criterion is established to choose the best solution from a group of possible solutions. The question of stability is examined. Finally, the effect of the elastic membrane normally used in triaxial testing on the behavior of the granular material is discussed. In certain important respects the limited analytical and numerical results appear to agree with experience in soil mechanics testing. —ASCE abstract

Paterson, Mervyn S. *See* Coe, Robert S. 04446

Peck, D. L. *See* Grommé, C. S. 04598

04873 **Pedersen, Asger Ken.** Preliminary notes on the Tertiary lavas of northern Disko, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 21-24, 1969.

During a period of regional basaltic volcanism during the Tertiary, some of the magma was trapped at high levels in the Precambrian basement and in Cretaceous sedimentary rocks. The magma differentiated and reacted with the various rocks which trapped it, resulting in a variety of basaltic lithologies, many with foreign inclusions within them. The resulting flows are described. —HRC

04750 **Peek, Harry M.** Effects of large-scale mining withdrawals of ground water: Ground Water, v. 7, no. 4, p. 12-20, illus., 1969.

Withdrawal of about 60 mgd from the Castle Hayne limestone, the most productive unit of the artesian aquifer of the North Carolina Coastal Plain, lowered the artesian head below sea level. The aquifer became vulnerable to encroachment of saline water from natural occurrences in the limestone and from leakage of brackish water through confining beds and the underlying sand member. The dramatic effects of large withdrawal at a mine site created enough concern to give the Board of Water and Air Resources authority to regulate withdrawal as needed; studies leading to a management program are in progress. Cross sections, a fence diagram, and two piezometric maps are included. —ESL

Perch-Nielsen, K. *See* Birkelund, B. 04979

04382 **Perrault, G.; Gelinas, L.** Associations minerales des accidents pegmatitiques du Mont St-Hilaire, P.Q. [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 143, 1969.

04383 **Perrault, G.; Vicat, J.; Sang, N.** UK-19-1 et UK-19-2, deux noveaux silicates hydrates de Mont St-Hilaire, P.Q. [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 143-144, 1969.

04551 **Perry, David V.** Skarn genesis at the Christmas mine, Gila County, Arizona: Econ. Geology, v. 64, no. 3, p. 255-270, illus., table, 1969.

Skarn and sulfide mineralization occurred concurrently in three Paleozoic carbonate formations and post-dated contact metamorphism. Types of skarn correspond to host-rock types: magnesian skarn in dolomite, calcium skarn in limestone, endoskarn zone inward from the porphyry margin. Sulfide mineralization formed within the temperature range 250°-600°C based on the assemblages and textures present. Many of the observed paragenetic relations are regarded as resulting from unmixing and in situ rearrangement, in response to lower temperature conditions, of the sulfides already present. Skarn-sulfide mineralization resulted in a volume loss. Carbonate favorability to skarn-sulfide mineralization is the result of reactivity. —*from* Author's abstract

04797 **Peters, W. C.** The economics of mineral exploration: Geophysics, v. 34, no. 4, p. 633-644, illus., tables, 1969.

Exploration activity within a region is controlled by an economic pattern based on changing conditions in mining practice, processing technology, and marketing opportunities. Exploration programs and new developments in exploration science must be viewed in the context of the rapidly changing concept of an ore body. Any exploration effort is essentially a profit-versus-risk affair. In evaluating potential profit versus risk, consideration should be given to evidence that the largest financial losses are often not in exploration but rather in the abandonment of an unprofitable mining operation after the commitment of a capital investment on the basis of incomplete geologic investigation. The decision as to when an anomaly is to be considered a target may be less critical than the decision as to when an investigated target is to be considered an ore body. —GV

Petersen, O. V. *See* Andersen, E. Krogh. 04907

04661 **Peterson, Melvin N. A.** Scientific goals and achievements: Ocean Industry, v. 4, no. 5, p. 62-67, illus., tables, 1969.

Major scientific accomplishments on the JOIDES Deep Sea Drilling Project were: Leg I, the Sigsbee Knolls are salt domes with cores containing petroleum, oldest rocks in the ocean (late Jurassic) were sampled near the Bahamas; turbidite flows containing chert and limestone were found in several places at great depths. Leg II, evidence of sea-floor spreading in that first-formed sediments became younger near the Ridge, at three sites core recovery contained basement rock (altered vesicular basalt), sediment characteristics show relation to basement formation; Leg III, evidence confirms sea-floor spreading, sediment depths are uniform but age distributions vary widely; and Leg IV, a widespread chert blanket ties Caribbean and North Atlantic to the Pacific, sediments of the Vema fracture zone were cored, and Barbados Island began as a block of ocean floor three miles down. —ESL

04618 **Peterson, S. F.; Travesi, A.; Morrison, G. H.** Rapid group separation method for neutron activation analysis of geological materials, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 624-633, illus., tables, 1969.

The complexities of gamma-ray spectra from multielement samples such as rocks often prevent determination of many elements by nondestructive instrumental methods. Chemical group separations have been developed for use previous to irradiation to permit full use of the high resolution semiconductor detectors. A large improvement in sensitivity, precision, time of analysis, and number of elements found has been noted in comparison to nondestructive activation analysis. The separation technique divides the sample into five groups; total time required is 3-4 hours with little attention needed from the operator. In the study, the USGS standard rock W-1 was used as a concentration standard and all other rocks (also standard samples) were compared to it. Resulting data are tabulated. —VSN

04716 **Peterson, S. F.; Tera, F.; Morrison, G. H.** Isotopic ion exchange separation of radioisotopes using an acetone-water-hydrochloric acid system: Jour. Radioanal. Chemistry, v. 2, nos. 1-2, p. 115-125, illus., table, 1969.

Isotopic ion exchange for the rapid separation of radioactive mixtures has been extended through the use of an acetone-water-hydrochloric acid system. Distribution data were obtained for 27 elements in the range of 15-90 percent acetone, 0.3 *N* HCl indicating a number of new separations. The approach was used for the separation of several radioisotopes from short half-life magnesium matrix for activation analysis. The separations were completed in less than five minutes. —Authors' abstract

04384 **Petruk, W.; Harris, D. C.; Cabri, L. J.; Stewart, J. M.** Native silver and silver-antimony minerals in the Cobalt-Gowganda ores [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 144, 1969.

04759 **Petryk, A. A.** Mesozoic and Tertiary stratigraphy at Lake Hazen, northern Ellesmere Island, District of Franklin: Canada Geol. Survey Paper 68-17, 51 p., illus., geol. map, 1969.

The Mesozoic and Tertiary beds exposed along the north shore of Lake Hazen were studied and sections were measured. Triassic sandstones and shales have been identified and tentatively correlated with the Bjorne, Schei Point and Heiberg Formations of western Ellesmere Island. The Jurassic and Cretaceous Awingak, Deer Bay, Isachsen, Christopher, and Hassel sandstone and shale formations also may be represented. About 6,000 feet of Mesozoic beds were measured and the total thickness may approach 8,000 feet. At least 500 feet of coal-bearing Tertiary sandstone, siltstone and shale overlie the tilted and eroded Mesozoic formations. —Author's abstract

Péwé, Troy L. *See* Reger, Richard D. 04491

04498 **Péwé, Troy L.** (editor). The periglacial environment, past and present—Internat. Assoc. Quaternary Research, 7th Cong., Fairbanks, Alaska, 1965, Symposium and

Field Conf.: Montreal, Quebec, McGill-Queen's Univ. Press (for Arctic Inst. No. America), 487 p., illus., tables, 1969.

This volume is the outgrowth of a symposium and field conference held in central Alaska in connection with the 7th INQUA Congress in 1965. Seventeen of the 29 papers presented are included in the volume, and six others have been added. The volume includes papers dealing with 15 countries; those on North America are cited separately by author. There are two major subdivisions of the volume, the first examines processes and features in the present periglacial environment, and the second cold-climate phenomena now found in temperate environments or other areas which no longer have active periglacial action. —HRC

04499 **Péwé, Troy L.** The periglacial environment [with French abs.], *in* The periglacial environment, past and present (T. L. Péwé, editor)—Internat. Assoc. Quaternary Research, 7th Cong., Alaska, 1965: Montreal, Quebec, McGill-Queen's Univ. Press, p. 1-9, illus., 1969.

This is a summary of the history of the concept of the periglacial environment (the term was first used in 1909), and a review of some of the current areas of investigation in the world. The increased interest in, and access to the polar regions has speeded acquisition of knowledge of periglacial areas. Permafrost is the common denominator in all areas and types of concepts. A former periglacial environment is assumed if permafrost can be demonstrated, the most obvious evidence being ice wedge casts. Permafrost forms where the mean air temperature is about -1°C, but it is now known that ice wedges require lower temperatures. Small-scale patterned ground and solifluction are also important features of the periglacial environment. —HRC

Philen, O. D., Jr. *See* Weed, S. B. 04508

04448 **Phinney, Robert A.; Alexander, Shelton S.** The effect of a velocity gradient at the base of the mantle on diffracted P waves in the shadow: Jour. Geophys. Research, v. 74, no. 20, p. 4967-4971, illus., table, 1969.

Asymptotic expressions for the P-wave solution near a turning point may be combined with the boundary conditions prevailing at the mantle-core boundary to obtain an asymptotic expression for the reflection coefficient at this boundary that preserves the diffraction effects of curvature and velocity gradient. Increasing the velocity gradient is shown to increase the decay coefficient for the diffracted wave in the shadow. Consideration of recent published data and some new short-period data suggests that regional differences in the decay of this signal may be due to difference in the gradient at the base of the mantle. —Authors' abstract

Phinney, W. C. *See* Wager, Robert E. 04849

Pierce, Arthur P. *See* Cannon, Ralph S., Jr. 04936

04895 **Pierce, J. W.** Sediment budget along a barrier island chain: Sed. Geology, v. 3, no. 1, p. 5-16, illus., table, 1969.

The sediment budget for a stretch of coast along a barrier chain is calculated from historical records of nearly 100 years, mapped short-term changes, and estimates of volume changes caused by physical processes. For the isolated North Carolina section studied, accretion has exceeded erosion. The sediment deficit requires an average annual input rate of 796,000 m^3, partially filled by longshore drift from adjoining sections and by biogenous contributions. Currents are insufficient to carry material from the mainland across the lagoons. Longshore drift and biogenous source cannot account for approximately 337,000 m^3 of sediment annually. It is postulated that this material is being moved in from a reservoir on the continental shelf. This reservoir is either unconsolidated relict sediments or outcrops of poorly consolidated Tertiary rocks only thinly veneered by Holocene sediments. —*from* Author's summary

Pilkey, Orrin H. *See* Field, Michael E. 04465

04693 **Pillay, K. K. S.; Miller, W. W.** Characteristic X-rays from (n, γ) products and their utilization in activation analysis: Jour. Radioanal. Chemistry, v. 2, nos. 1-2, p. 97-107, illus., tables, 1969.

The possibility of using characteristic X-rays from radioactive elements in activation analysis was investigated with particular emphasis on (n, γ) products. At least 27 of 56 elements investigated were found to yield themselves to activation analysis employing characteristic X-rays from electron capture or internal conversion processes during isomeric transition. In presenting the results, a survey made of several elements and the limits of detection of 21 elements have been reported. Specific applications of this method were studied for the analysis of copper in a variety of samples (ores, minerals, steels, spent lubricants and human blood). The results show that the use of characteristic X-rays in activation analysis has several advantages because energies of these radiations are closely related to periodicity of the elements themselves. —*from* Authors' abstract

05010 **Pillmore, C. L.** Geology and coal deposits of the Raton coal field, Colfax County, New Mexico, *in* Raton basin field trip, Colorado and New Mexico, 1969, Guidebook: Mtn. Geologist, v. 6, no. 3, p. 125-142, illus., tables, 1969.

High-volatile A and B coals have been mined since 1870. Rocks are Late Cretaceous and Paleocene, and are about 6,000 feet thick in the center of the field. The coal is in the Cretaceous Vermejo Formation. The upper part of the Paleocene Raton Formation is also coal-bearing. The most extensive, however, is the Raton bed, in the Vermejo, and a group of beds in the upper part of the Raton Formation. The Raton bed occurs as a thick elongate deposit that trends north to northeastward. Only the York Canyon coal bed in the Raton group is being currently mined. Tertiary dikes have intruded the area and destroyed large amounts of coal, but large amounts still remain. —*from* Author's abstract

04454 **Plafker, George; Kachadoorian, Reuben; Eckel, Edwin B.; Mayo, Lawrence R.** The Alaska earthquake—Effects of the earthquake of March 27, 1964 on various communities: U.S. Geol. Survey Prof. Paper 542-G, p. G1-G50, illus., tables, 1969.

Damage to some 33 communities throughout the earthquake-affected area of Alaska resulted primarily from water waves of diverse origins, tectonic displacements, and seismic shaking. Destructive waves, generated mainly by (1) earthquake-triggered subaqueous slides and (2) regional horizontal and vertical tectonic movements, took 31 lives and caused most of the property damage at the shoreline communities. Uplift and subsidence of the land relative to sea level had long-term adverse effects on most coastal communities in the deformed region. Structural damage from seismic shaking was relatively minor and was virtually restricted to foundation failures in areas of thick water-saturated unconsolidated deposits. —GP

04371 **Platt, R. G.; Sood, M. K.; Edgar, A. D.** Phase relations in parts of the system diopside-nepheline-kalsilite-silica and their importance to alkaline rock genesis [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 144-145, 1969.

04744 **Poag, C. Wylie.** The Pliocene-Pleistocene boundary in the Gulf Coast region [discussion of paper by J. H. Beard and J. L. Lamb, 1968]: Tulane Studies Geology and Paleontology, v. 7, no. 2, p. 72-74, 90, 1969.

Beard and Lamb (Gulf Coast Assoc. Geol. Socs. Trans., v. 8, p. 174-186, 1968) have based the late Neogene biostratigraphy for the entire Gulf Coast and Caribbean region on the stratigraphic sequence of planktonic Foraminifera in a single piston core from Sigsbee Knolls in the Gulf of Mexico. Poag points out that they have ignored previously published species ranges listed by Poag and Akers (1967) and others, have not resolved contradictory interpretations of paleotemperature changes across Pliocene-Pleistocene boundaries proposed by various authors, and have misinterpreted the positions of Pliocene-Pleistocene boundaries charted by Poag and Akers (1967) and others. Moreover, correlation with the Pliocene-Pleistocene of the Mediterranean should not be attempted until species ranges in both regions are more firmly established. —VMJ

Podolsky, T. *See* Wager, Robert E. 04849

04470 **Poland, J. F.; Davis, G. H.** Land subsidence due to withdrawal of fluids, *in* Reviews in engineering geology, V. 2 (D. J. Varnes and George Kiersch, editors): Boulder, Colo., Geol. Soc. America, p. 187-269, illus., tables, 1969.

This paper reviews the known examples of appreciable land subsidence due to fluid withdrawal. Those related to oil and gas fields are Goose Creek, Texas; Wilmington, California; Lake Maricaibo, Venezuela; Nigata, Japan; and the Po delta, Italy. Subsidence related to withdrawal include areas in Japan, Mexico City, and the United States. The principles involved in compaction of sediments and of aquifer systems, basically the increase in effective stress, are examined briefly, together with their application to subsidence problems. The amount of compaction that a confined aquifer will experience is a function of compressibility. Other factors are particle size and shape, clay mineralogy, geochemistry of pore water in the clayey beds and of the water in continguous aquifers, and secondary compression. —*from* Authors' abstract

04774 **Pond, Alonzo W.** Caverns of the world: New York, W. W. Norton and Co., 178 p., illus., 1969.

This popular account of world caves contains 21 chapters as follows: discovery blast; limestone—bedrock of the cavern world; caverns are born below the water table; karst, what's that?; vadose water—nature's artist; trickle and puddle formations; flowers that grow in the dark; sea caves and waterfall rooms; lava tubes; glaciers, or ice caves; when the Earth breathes; cave life; Chiroptera—bats; how to find a cave; thrills and courage in cave discoveries; famous caves; caverns in music, legend, and history;cavern uses; caverns as habitation; cave art; and mountain climbing in the dark. —MCM

Poole, F. G. *See* Shawe, D. R. 04550

Poort, Jon M. *See* Wermund, E. G. 04522

Pope, A. Y. *See* Caudle, W. N. 04950

Porter, J. W. *See* Fuller, J. G. C. M. 04820

04603 **Post, Austin.** Distribution of surging glaciers in western North America [with French and German abs.]: Jour. Glaciology, v. 8, no. 53, p. 229-240, illus., table, 1969.

In western North America, 204 surging glaciers have been identified by aerial photographic observations. Distribution of these is not random, as they occur only in the Alaska Range, eastern Wrangell Mountains, eastern Chugach Mountains, Icefield Ranges, and St. Elias Mountains near Yakutat and Glacier Bay; no definite reason for this restricted distribution is apparent. Surging glaciers are found in maritime to continental and temperate to subpolar environments. The distribution does not relate to topography, bedrock type, altitude, orientation, or size. Some are associated with fault-related valleys, but neither recent faulting nor earthquakes have initiated surge activity. Possible causes are unusual bedrock roughness or permeability, anomalously high ground-water temperatures, and/or abnormal geothermal heat flow. —*from* Author's abstract

Potter, Paul Edwin. *See* Hrabar, S. V. 04726

Potter, Paul Edwin. *See* Shimp, N. F. 04816

04385 **Poulliot, G.** Study of carbonate minerals from the carbonatite at Oka, Quebec [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 144, 1969.

04668 **Poulson, Thomas L.; White, William B.** The cave environment: Science, v. 165, no. 3897, p. 971-981, illus., table, 1969.

Limestone caves provide unique natural laboratoies for studying biologic and geologic processes. This paper includes discussions of hydrologic regimes in karst regions and of caves as mineralogic laboratories. In the latter connection, "moonmilk" is of

particular interest because of its peculiar mineralogy and the possible involvement of bacteria in its formation. Many cave processes are freshwater analogs of processes occurring on the ocean floor; carbonate deposition in particular can be studied in place, and it turns out to be a remarkably complicated process. —DBV

Powell, J. Dan. *See* Kauffman, Erle G. 04961

Press, Frank. *See* Wiggins, Ralph A. 04494

04701 **Prinz, Martin; Nehru, C. E.** Comments on "Kaersutite from San Carlos, Arizona, with comments on the paragenesis of this mineral" by Brian Mason [1968]: Mineralog. Mag., v. 37, no. 287, p. 333-337, 1969.

Electron probe analyses have been made of eight kaersutites from San Carlos, Arizona, and one from Kakanui, New Zealand; also of olivine, clinopyroxene, ilmenite, and spinel from San Carlos. There is not as yet adequate evidence that the kaersutite is an upper mantle phase. [Original paper, ibid., v. 36, no. 283, p. 997-1002, 1968.] —Authors' abstract

Protz, R. *See* Gillespie, J. E. 04684

Pusey, Walter C. *See* Chuber, Stewart. 04481

04365 **Radcliffe, Dennis.** Cell constants of Birch Portage beryl, Saskatchewan: Canadian Mineralogist, v. 10, pt. 1, p. 104-105, tables, 1969.

To improve precision and accuracy of measurements of cell edges on three beryl crystals (reported by Radcliffe and Campbell, 1966), cell edges were calculated simultaneously by least squares analysis on at least 15 uniquely indexed reflections. A discrimination of tolerance 0.01-0.05° (2θ) was utilized; any two hkl values with calculated 2θ with a difference less than 0.01° were excluded from computations. This was done automatically with an IBM 7094 computer using the Evans, Appleman, and Hardwerker program (1963). Results are tabulated. —VSN

Radtke, Arthur S. *See* Taylor, Charles M. 04553

04440 **Rahn, Perry H.** The relationship between natural forested slopes and angles of repose for sand and gravel: Geol. Soc. America Bull., v. 80, no. 10, p. 2123-2128, illus., 1969.

The angle of repose in fresh sand and gravel talus exposed in artificial pits in a kame terrace near Willimantic, Connecticut, averages 33.08°, and is independent of exposure direction or material type. The slope of natural forested hillslopes of the same sand and gravel along a terrace scarp cut by the Nachaug River averages 41.29° and is also independent of exposure direction. The difference between the angle of repose and the natural hillslope is attributed to the stabilizing influence of the forest vegetation. —*from* Author's abstract

04626 **Randle, Keith; Goles, Gordon G.** Ge(Li) detectors in the activation analysis of geological samples, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 347-352, illus., table, 1969.

A general discussion is given of experimental methods used in analysis of elements in geological samples at the Center for Volcanology of Oregon University by neutron activation techniques using a Ge(Li) detector. The systems used permit geochemically important elements to be determined without chemical separations. The approximate lower limits of abundances which can be determined in silicic and basic rocks are tabulated. The method has been used in an effort to distinguish between ash falls from several volcanic sites in Oregon. Preliminary results indicate that trace-element data may be useful. An improvement in sensitivity of the method is obtained by use of an anti-Compton shield around the detector, and another extension is obtained from NaI(Tl)-Ge(Li) coincidence measurements. This latter procedure is mainly applicable to meteorites. —VSN

04885 **Rankama, Kalervo.** Global Precambrian stratigraphy: Soc. Sci. Fennica Årsb. 1966-67, v. 45B, p. 1-15, illus., table, 1969.

This review paper summarizes worldwide studies on the age of the oldest rocks of the Earth and the schemes used on the various continents for division of the immense amount of time represented by the Precambrian era. Recent advances in knowledge, particularly the better understanding of the fossil content, indicate that many of the older subdivisions should be discarded. It is possible that studies in Australia will provide the basis for a worldwide chronostratigraphic scheme for the Precambrian. —VSN

04439 **Rapp, George, Jr.** Studies on the pegmatite minerals of the Black Hills, South Dakota, *in* National Geographic Society research reports 1964 (Paul H. Oehser, editor): Washington, D.C., Natl. Geog. Soc., p. 181-182, 1969.

Over 280 mineral species occur in the Black Hills, most being found in pegmatites of the region. Numerous secondary phosphate minerals are generated by deuteric reactions. Forty-four phosphate minerals were collected and identified. Crystal-chemical research was concentrated on determining chemical and structural changes during the solid state alteration of the primary phosphate-mineral series triphylite-lithiophilite to secondary phosphates including the sicklerite series and the heterosite-purpurite series. A triphlite from the Dan Patch pegmatite and lithiophilite from the Custer Mountain pegmatite have been analyzed, and alteration is shown to be due to deuteric action rather than oxiation by meteoric waters. The crystal structure of triphylite and leucophosphite are being determined; while good crystals of leucophosphite are rare, excellent crystals were collected from the Bull Moose pegmatite. —HRC

04729 **Rasmussen, William.** Examples of routine computer processing in applied mineral exploration geophysics [abs.]: Mining Eng., v. 21, no. 8, p. 42, 1969.

Rasnick, Frank D. *See* McCormick, J. Edward. 04575

04670 **Rathbun, R. E.; Guy, H. P.; Richardson, E. V.** Response of a laboratory alluvial channel to changes of hydraulic and sediment-transport variables: U.S. Geol. Survey Prof. Paper 562-D, p. D1-D3, illus., tables, 1969.

The feed and recirculation systems of flume operation were compared in experiments in a tilting plastic flume. No significant differences were observed in mean values of sediment-transport rate, water-surface slope, depth of flow, and mean velocity for the two systems in the equilibrium steady state. Responses of the alluvial channel with constant water discharge to changes of sand-bed slope, tail-water depth, and sediment-transport rate were determined. —*from* Authors' abstract

04912 **Raup, Hugh M.** Observations on the relation of vegetation to mass-wasting processes in the Mesters Vig district, northeast Greenland: Medd Grönland, v. 176, no. 6, 216 p., illus., tables, 1969.

Complementary to A. L. Washburn's (1967) publication on instrumental observations of mass wasting, this paper contains botanical analyses of six experimental sites reported in that publication. For each site, there are descriptions of topography and soils, moisture supply, frost heaving, downslope movement of targets by gelifluction and frost creep, and disturbance by erosion or other processes. The study is summarized in terms of vegetation habitats, using analysis by species tolerance ratings on gradients of ground coverage, moisture, and physical disturbance of the soil. Sparse fjaeld-mark vegetation apparently has been caused largely by variations in moisture supply interacting with physical disturbance of the soils. —*from* Author's abstract

04554 **Raymahashay, Bikash C.; Holland, Heinrich D.** Redox reactions accompanying hydrothermal wall rock alteration: Econ. Geology, v. 64, no. 3, p. 291-305, illus., tables, 1969.

Log f_{sulfur}-log f_{oxygen} diagrams were used to predict reaction paths for redox reactions involving iron and sulfur. "Contours of total dissolved sulfur concentration at 250°C

and 350°C calculated on the basis of the available thermochemical data and partially checked by direct experiment, were superimposed on the mineralogical boundaries of the Fe-S-O system." The mineral sequences formed during the replacement of iron oxides or silicates vary with trend of reaction path and initial total dissolved sulfur concentration. The proposed scheme fits observations at Butte, northern Boulder batholith, and Ely. —WSW

Reed, John H. *See* Mandler, John W. 04615

Reeh, Niels. *See* Olesen, Ole B. 04924

04491 **Reger, Richard D.; Péwé, Troy L.** Lichenometric dating in the cental Alaska Range [with French abs.], *in* The periglacial environment, past and present (T. L. Péwé, editor)—Internat. Assoc. Quaternary Research, 7th Cong., Alaska, 1965: Montreal, Quebec, McGill-Queen's Univ. Press, p. 223-247, illus., table, 1969.

A tentative growth curve for *Rhizocarpon geographicum* was determined, based upon lichen diameters on dendrochronologically-dated Recent moraines of Black Rapids and Canwell glaciers. The prominent Recent moraines of nearby Gulkana and College glaciers, which lie entirely above the tree line, were then dated by comparison of the diameters of the lichens with the growth curves established on the dated moraines. These latter moraines were formed by glacial advances in 1580(?), 1650(?), and 1875. The growth rate of *Rhizocarpon geographicum* in the central Alaska Range compares favorably with growth rates recorded in the Alps. —*from* Authors' abstract

Reid, Alton C. *See* Tullos, Frank N. 04781

04929 **Renshaw, G. D.; Roscoe, C.** Thermal stability of γ-ferric oxide: Nature, v. 224, no. 5216, p. 263-264, illus., table, 1969.

Further evidence is presented for the persistence of the γ-Fe_2O_3 lattice at temperatures far in excess of the reported transformation temperature of about 300°C. The minimum detectable amount was produced at 625°C. The results also agree with reports that the topotactic transformation of Fe_3O_4 to γ-Fe_2O_3 during oxidation is promoted by the presence of trace quantities of water vapor. —DBV

Renson, Irwin. *See* Hornberger, G. M. 04829

Requist, Norris. *See* Mark, Anson. 05007

Requist, Norris. *See* Mark, Anson. 05009

04920 **Rettger, Robert E.** Frederic Henry Lahee (1884-1968): Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 2014-2015, portrait, 1969.

04904 **Ribbe, P. H.; Megaw, Helen D.; Taylor, W. H.; Ferguson, R. B.; Traill, R. J.** The albite structures—An analysis based on experimental measurements: Acta Cryst., v. B25, pt. 8, p. 1503-1518, illus., tables, 1969.

Three-dimensional analyses of low and high albite studied in 1958 confirm that in low temperature material, Al, Si distribution is highly ordered, in high temperature is almost completely random, and also confirm marked anisotropy of the Na atom in both materials. Observed anisotropy of the Na atom in low albite may be interpreted in terms of a multipartite structure with faulted domains, though an explanation in terms of anisotropic thermal vibration is more probable. For high albite, the very large anisotropy of the Na atom and diffuse nature of atomic peaks of electron density, point to interpretation of the diffraction pattern as representing only an average structure; in this material evidence for a multipartite structure with faulted domains is considerably stronger than for low albite. An appendix compares effects of temperature factor with those of 'splitting' of atoms. —*from* Authors' abstract

Rice, G. W. *See* Mathieu, P. G. 04782

Rice, Raymond M. *See* Bailey, Robert G. 04888

Richardson, E. S., Jr. *See* Zangerl, Rainer. 04894

Richardson, E. V. *See* Rathbun, R. E. 04670

04934 **Richter, C. F.** Transversely aligned seismicity and concealed structures: Science, v. 166, no. 3902, p. 173-178, illus., 1969.

Lines of epicenters often trend transversely with respect to the larger surface structures, not only in the case of deep-focus earthquakes but also of ordinary shallow shocks. Such transverse alinements are often associated with boundaries of active areas, and are presumably due to fractures cutting across the principal structures. In many areas they parallel alternative trends evident elsewhere in the general region, expressing alternative directions of shearing; thus they need not conform closely to present strains and tectonic dislocations. Rather, they represent established zones of weakness of considerable geologic antiquity. They may have originated under conditions widely different from the present ones, but they will still determine the lines along which current dislocations are taking place. —DBV

Riley, D. L. *See* Herzenberg, C. L. 04928

04386 **Rimsaite, J.** Evolution of zoned micas and associated silicates in the Oka carbonatite [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 145, 1969.

04672 **Ristow, Walter W.** Erwin Raisz, 1893-1968: Special Libraries Association (New York) Geography and Map Division Bulletin, no. 75, p. 9-10, 1969.

04812 **Robinove, Charles J.; Anderson, Daniel G.** Some guidelines for remote sensing in hydrology: Water Resources Bull., v. 5, no. 2, p. 10-19, illus., table, 1969.

The values and limitations of remote sensing data and techniques are reviewed. Like other new techniques, remote sensing "will have its pitfalls, many of which probably can be avoided by proper planning of projects and through knowledge of the capabilities of remote-sensing systems. It is the task of the hydrologist, at this time, to assess his needs for data, to match them with the capabilities of remote-sensing systems and the currently used data collection systems, and to use them in the most beneficial way." —ESL

04902 **Robinson, J. E.** Spatial filters for geological data: Oil and Gas Jour., v. 67, no. 37, p. 132-134, 138, 140, illus., 1969.

Most forms of geological information that can be displayed on a map as discrete numerical values and contoured, may have some of their attributes enhanced by spatial or two-dimensional wavelength filtering, a computer-oriented method of extracting individual features and trends from a heterogeneous background. If the original geological information is sufficiently detailed and accurate, the filtered maps will contain only features whose length, width, and trend are mathematically rigorous. Spatial filtering techniques used in the analysis of structure contour maps covering portions of the interior plains of Alberta defined small-scale trends that were hidden in the original map. —HHA

04545 **Robinson, Michael; Clayton, Robert N.** Carbon-13 fractionation between aragonite and calcite: Geochim. et Cosmochim. Acta, v. 33, no. 8, p. 997-1002, tables, 1969.

Aragonite and calcite were precipitated from bicarbonate solutions by slow removal of carbon dioxide at 25°C. Carbon isotope fractionation factors (expressed as 1000ln α) are: calcite-bicarbonate ion 0.9 ± 0.2; aragonite-bicarbonate ion 2.7 ± 0.2; aragonite-calcite 1.8 ± 0.2. Theoretical calculation of the aragonite-calcite fractionation gives 0.9. —Authors' abstract

04958 **Rocky Mountain Assoc. Geologists; Gerhard, Lee C.** (editor). Raton basin field trip, Colorado and New Mexico, 1969, Guidebook: Mtn. Geologist, v. 6, no. 3, p. 79-190, illus., tables, 1969.

This issue is devoted to a field trip in the Raton Basin area of Colorado and New Mexico, held in September of 1969. It contains seven papers dealing with various aspects of the Precambrian to Cretaceous geology of the region, and road logs for a three day field trip. All are cited separately. —HRC

04547 **Roedder, Edwin.** Fluid-inclusion evidence on the environment of formation of mineral deposits of the southern Appalachian Valley [abs.]: Econ. Geology, v. 64, no. 3, p. 353, 1969.

Roen, J. B. *See* Kent, B. H. 04938

04456 **Rogers, John J. W.** Tyee Formation—Undeformed turbidites and their lateral equivalents, mineralogy and paleogeography—[Discussion of 1969 paper by J. P. B. Lovell]: Geol. Soc. America Bull., v. 80, no. 10, p. 2129-2130, 1969.

A discussion of the above paper by J. P. B. Lovell (ibid., v. 80, no. 1, p. 9-22, 1969) takes exception to Lovell's contention that the Klamath Mountains are the sole provenance of the Tyee Formation, an Eocene formation of the Washington-Oregon Tertiary eugeosyncline. By means of a mass balance calculation of plutonic quartz in the sediments of the eugeosyncline, Rogers demonstrates that the Klamath Mountains could not have supplied all detritus in the geosyncline. —RGY

04591 **Romey, William D.** Anorthite content and structural state of plagioclases in anorthosites: Lithos, v. 2, no. 1, p. 83-108, illus., tables, 1969.

X-ray powder data on 2θ separations and optical data on anorthite contents of labradorites from an anorthosite complex on Flakstadoy, Norway, show that labradorite in troctolite at the center of the complex is in a high-transitional structural state. That in anorthosite overlying troctolite and in norite underlying it is in a low-transitional structural state. Field evidence suggests that anorthosite and norite crystallized early and troctolite late. Studies of 30 andesines and labradorites from other anorthosites show that of plagioclases studied, those from North America [New York, Labrador] and the Bushveld are mainly in low- to high-transitional structural states, while those from South Norway lie close to curves for low plagioclase. —*from* Author's abstract

Ronai, Lili E. *See* Ellis, Brooks F. 04582

04949 **Rooney, Lawrence F.** The industrial minerals geologist or who killed Clem Kadiddlehopper, *in* Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, p. 33-44, illus., 1969.

Some remarks on the value, role, and education of the industrial minerals geologist are tendered, and examples are cited from Indiana. Examples of the relation between urbanization and mineral production are cited. The gypsum and anhydrite deposits in northern Indiana have not been adequately studied and should be examined by geologists more thoroughly, considering the market potential in the region. The apparent diversion of the brightest geology students into PhD programs, and hence specialization, has affected the industrial minerals industry considerably, as able generalists seem to be needed. —HRC

Roscoe, C. *See* Renshaw, G. D. 04929

Rosenberg, P. E. *See* Herman, Yvonne. 04942

04872 **Rosenkrantz, A.** New mapping and special research on Nûgssuaq and Disko, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 14-17, 1969.

Shale samples of oil source rock were collected, as were shales which were examined for Foraminifera. Textures and current directions were clarified from a thick conglomerate unit at the base of the Danian. At Marrait kitklit, a thorough investigation of a Danian tuff series was made; the tuff is overlain by pillow lavas, and some of the sediments contain unmistakable evidence of volcanic action which may be the source of the demise of the organisms in the rocks. The tuffs are cut by xentolite-bearing dikes. Cretaceous mollusks were collected from rocks near Agatdal. —HRC

04628 **Rosholt, J. N.; Szabo, B. J.** Determination of protactinium by neutron activation and alpha spectrometry, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 327-333, illus., tables, 1969.

An activation technique for protactinium analysis is described in which Pa-231 is transformed partially to U-232. The technique is of particular importance for application to the radioactive disequilibrium method of absolute age determination on Pleistocene materials. Activity ratios of U-234/U-238, Th-230/U-234, and Pa-231/U-235 and uranium and thorium concentration in some volcanic rocks from Hawaii, California, Nevada, and Iceland are tabulated. —VSN

04538 **Ross, Charles A.** Sedimentary rocks and tectonic setting of the Gaptank Formaton [summ.], *in* A guidebook to the stratigraphy, sedimentary structures and origin of flysch and pre-flysch rocks of the Marathon basin, Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 93-104, illus., 1969; originally published 1967.

This Late Pennsylvanian Formation was deposited on the northern slope of the nearly stabilized orogenic thrust belt in environments continually modified by sea level changes, subsidence, warping, and basinward migration. There are a number of cyclically repeated carbonate tracts which include shallow-shelf, shelf edge, and deeper water limestones, and these tracts separate shallow-water clastic sediments to the southeast from deeper water sandstone, siltstones, and shales to the northwest. The continued construction and outward migration of the edge of the shallow carbonate shelf was accompanied by a progressive morphological and lithological differentiation of the shelf-edge and shallow-shelf environments. —*from* Author's conclusions

Roy, Rustum. *See* Vezzoli, Gary C. 04935

04350 **Rucklidge, J. C.; Gibb, F. G.; Fawcett, J. J.; Gasparrini, E.** Rapid rock analyses by electron probe [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 145-146, 1969.

04488 **Rudberg, Sten.** Distribution of small-scale periglacial and glacial geomorphological features on Axel Heiberg Island, Northwest Territories, Canada [with French abs.], *in* The periglacial environment, past and present—Internat. Assoc. Quaternary Research, 7th Cong., Alaska,1965: Montreal, Quebec, McGill-Queen's Univ. Press, p. 129-159, illus., 1969.

A map shows the distribution of small-scale periglacial and glacial features. Outcrops are few and are mainly in rock walls and other sites where erosion is active. Rock waste covers all of the higher slopes and is dependent upon the rock in place. The fine materials are transported by wash. Striae are found up to 240-250 m above sea level; till is found to this altitude and a few patches occur up to 600-800 m. Nonsorted patterned ground is frequent in glacial deposit areas whereas the sorted forms are mainly in coarse, local debris. Running water is the most important form of erosion at present and the major landscape forms are due to this rather than glaciation. —*from* Author's abstract

Rumeau, J. L. *See* Kulbicki, G. 04605

04467 **Rupke, N. A.** Sedimentary evidence for the allochthonous origin of *Stigmaria*, Carboniferous, Nova Scotia: Geol. Soc. America Bull., v. 80, no. 10, p. 2109-2114, illus., table, 1969.

The usual occurrence of *Stigmaria*, subparallel to the bedding and with *Appendices* attached to it in radial arrangement, has been considered proof of growth *in situ* of this plant fossil. Four sedimentary features of *Stigmaria* in the Carboniferous cliff sections of Nova Scotia contradict validity of this argument and indicate transportation of the stigmarian specimens. These features are: (1) preferred orientation of *Stigmaria* axes, (2) their fragmentation, (3) filling of stigmarian fragments with sediment different from enveloping rock, and (4) evidence of rapid accumulation of beds containing *Stigmaria*. The *Appendices* believed to have been very soft, may have been

rather stiff. Paleoecological interpretations of stigmarian beds, if originally based on supposed growth in situ of *Stigmaria*, require reconsideration. —*from* Author's abstract

Rye, Robert O. *See* Tourtelot, Harry A. 04425

Sabina, Ann P. *See* Jambor, J. L. 04363

04762 **Saitta Bertoni, Sandro.** Environment of deposition of an ancient delta—The Bluejacket Formation in northeastern Oklahoma [with Spanish abs.]: Asoc. Venezolana Geología, Minería y Petróleo Bol. Inf., v. 12, no. 5, p. 109-150, illus, table, 1969.

The conclusion that the Bluejacket Sandstone was deposited in a large complex deltaic environment is supported by stratigraphic correlations, isolith, isopach, and sand/shale ratio maps, sedimentary structures, textural analysis of sand, and textural interpretation of SP curves. Paleocurrents, maximum distribution of sand thickness, and isopach maps indicate a NW-SE paleoslope. Festoon crossbedding, laminations and small current ripple crossbedding, and laminated and medium scale crossbedded strata indicate a current origin for the sand. Variation of grain size distribution and sedimentary structures are indicative of fluctuations of current velocity. The Inola and Brown Limestones, thought to be time parallel units, were deposited in transgressive phases, and the sandstone in a regressive phase of the Cherokee Sea. SP curve shapes were classified to aid in determination of depositional environments. —*from* Author's abstract

04675 **Samson, J. C.** Deep resistivity measurements in the Fraser Valley, British Columbia: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1129-1136, illus., table, 1969.

Deep resistivity soundings were made in the Fraser Valley, British Columbia, using signals induced by a large, direct-current, dipole source. Interpretation of apparent resistivity data indicates that 500 m of conducting ocean sediments overlie a resistive second layer and conducting third layer. A comparison of resistivity data with well data indicates that the resistive layer is composed of 4-5 km of sedimentary rocks covering 2-4 km of granitic rocks. The extremely low resistivity in the third layer is probably due to water saturation of the granitic to intermediate rocks at this depth. —Author's abstract

04909 **Sandhu, Ranbir S.; Wilson, Edward L.** Finite-element analysis of seepage in elastic media: Am. Soc. Civil Engineers Proc., v. 95, paper 6615, Jour. Eng. Mechanics Div., no. EM3, p. 641-652, illus., 1969.

A variational principle is used in conjunction with the finite-element method to solve the initial boundary value problem of flow in a saturated porous elastic medium. This results in a powerful solution technique for the determination of stress and displacement history, both for the solid and the liquid phases, for arbitrary boundary conditions and within complex geometrical configurations. Direct application is to problems of consolidation and drainage of saturated soils under load. Linear theory of the coupled fields is treated but extension to nonlinear problems is possible through use of incremental procedures. —ASCE abstract

Sang, N. *See* Perrault, G. 04383

Santhanam, A. T. *See* Gupta, Y. P. 04505

Santos, Gabriel G. *See* Uken, Ernst A. 04612

04512 **Sargent, K. A.** Petrography and heavy minerals of three groups of rhyolitic lavas, Pahute Mesa, Nevada Test Site, *in* Geological Survey research 1969, Chap. C: U.S. Geol. Survey Prof. Paper 650-C, p. C18-C24, illus., tables, 1969.

Three groups of Tertiary rhyolitic lavas closely related to known volcanic centers occur on Pahute Mesa in the northern part of the Nevada Test Site. The lavas are

useful stratigraphic markers in thick volcanic sections inasmuch as they can be identified and correlated by means of petrography and heavy minerals. Diagnostic nonopaque heavy-mineral assemblages for the three groups are (1) rhyolitic lavas of Quartet Dome—clinopyroxene, olivine, and amphibole, (2) upper rhyolitic lavas of Area 20—biotite and allanite, and (3) lower rhyolitic lavas of Scrugham Peak quadrangle—biotite, sphene, hornblende, and(or) clinopyroxene.—Author's abstract

04458 **Saul, John M.** Study of the Spanish Diggings, aboriginal flint quarries of southeastern Wyoming, *in* National Geographic Society research reports 1964 (Paul H. Oehser, editor): Washington, D.C., Natl. Geog. Soc., p. 183-199, illus., table, 1969.

These are a group of quarries used as sources of chert for weapons and tools by ancient men, not the Spaniards, as the name suggests. There are several chert-bearing units in the area, the oldest being the Devonian Guernsey Formation, over which lies the Hartville Formation, the upper part of which contains chert. Above the Hartville are several other formations of Permian, Triassic, and Jurassic age. The materials were used by Clovis culture people and younger, and have been quarried since the time of the McKean complex at about 2000 B.C. The chert was used in preference to the quartzite which was also available for projectiles, but the quartzite was used for other purposes. An appendix lists projectile point sizes, types, and lithologies. —HRC

04416 **Savage, E. Lynn.** Device for direct measurement of true dip from apparent dip: Geol. Soc. America Bull., v. 80, no. 10, p. 2067, illus., 1969.

An easily constructed nonmagnetic lightweight device consisting of a small plane surface to which two moveable arms are attached has been successfully used to form the true dip plane where only apparent dips are available. Measurements of strike and dip with a Brunton compass using the surface of the device as the true dip surface eliminates additional measurement as well as all calculations. It is also useful where bedding planes are too small to make readings on, as well as on hard rock where only bedding traces are visible. The device has proved to be exceptionally useful where many measurements of cross-strata were required. —Author's abstract

04867 **Sayers, R. W.; Tippett, M. C.; Fields, E. D.** Ore deposits at Copper Canyon and Copper Basin, Lander County, Nevada: Soc. Mining Engineers Trans., v. 244, no. 3, p. 320-331, illus., 1969.

Porphyry copper deposits at Copper Canyon and Copper Basin form an economic unit requiring integrated exploitation; in both, hypogene metallization occurs within large aureoles of metamorphism and hydrothermal alterations related to mid-Tertiary quartz-monzonite intrusions. Supergene processes further altered the rocks and enriched the hypogene protore. At Copper Canyon hypogene copper and iron sulfides with gold and silver occur in fractures, as partial replacement of favorable beds, and as disseminations in Paleozoic sedimentary rocks; the lower Pennsylvanian Battle formation was a favorable host. Metallization occurs to a lesser extent in quartz monzonite. Deposits at Copper Basin consist of supergene copper minerals in arenites of the Cambrian Harmony formation. Oxidation of hypogene copper and iron sulfides in tactite zones has formed at least two commercial deposits. —*from* Authors' abstract

04694 **Schenk, Paul E.** Carbonate-sulfate-redbed facies and cyclic sedimentation of the Windsorian Stage (Middle Carboniferous), Maritime Provinces: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1037-1066, illus., 1969.

Windsorian carbonates are mainly shallow marine to supratidal; calcium sulfate is mainly diagenetic and supratidal, precipitated within, not on, subaerial salt flats; and red beds are mainly subaerial and diagenetic, pigmented by postdepositional alteration of iron-rich detrital minerals. Dolomitization was both penecontemporaneous within the salt flat by influxing lagoonal water, and also secondary within buried, permeable, basinward lithosomes, by refluxing brine. Gypsum-anhydrite nodules metamorphose on stress from mosaic, through penemosaic structures, and finally to massive, porphyroblastic plutons. Floodings in the Antigonish-Mabou basin were

from the north, the present Gulf of St. Lawrence. Cyclic sedimentation was probably due to fluctuating supply of terrigenous detritus into a continually subsiding basin. —*from* Author's abstract

04802 **Schilling, Jean-Guy; Winchester, John W.** Rare earth contribution to the origin of Hawaiian lavas: Contr. Mineralogy and Petrology, v. 23, no. 1, p. 27-37, illus., tables, 1969.

Rare earth abundances in twenty Hawaiian lavas and one diabase demonstrate a systematic relationship between rare earth abundances and the petrochemistry of these rocks. Three distinct lava groups are recognized: (1) tholeiites, (2) alkali series, and (3) nepheline-melilite basalts. Based on rare earths: (a) The hawaiites and mugearite of the alkali series represent residual melts derived from alkali olivine basalts, most likely by fractional crystallization; the trachyte, however, seems to have a more complicated history. (b) Fractional crystallization models linking nephelinites or alkali olivine basalts to tholeiites are possible. However, production of these three lava groups, independently, by various degrees of partial melting of the mantle is equally likely. (c) Daly limestone syntexis hypothesis to produce the nephelinites is unlikely. —*from* Authors' abstract

Schlater, J. E. *See* Chun, D. 04697

Schleicher, J. A. *See* Shimp, N. F. 04816

04734 **Schmidt, R. G.** Fracture pattern analysis in groundwater exploration and development [abs.]: Mining Eng., v. 21, no. 8, p. 44, 1969.

Schmidt-Bleek, F. *See* Case, D. R. 04616

04843 **Schmucker, U.** Geophysical aspects of structure and composition of the Earth, Chap. 6 *in* Handbook of geochemistry, V. 1 (K. H. Wedepohl, editor): Berlin and New York, Springer-Verlag, p. 134-226, illus., tables, 1969.

Correlation of data on propagation velocity of seismic waves, results of laboratory experiments on behavior of rocks and minerals under high temperature-pressure conditions, and other geophysical data such as gravity, magnetic, and heat-flow values, permits formulation of general values for the chemical composition and energy balance of the Earth's interior. The data confirm geochemical conclusions and indicate that the crust originated from the upper mantle and was later periodically subjected to fractional melting. The upper third of the continental crust is granitic to granodioritic and may grade into gabbroic material near the base; below the oceans the crust is a consolidated layer of basaltic melts. A peridotite composition is postulated for the upper mantle, with a minor gabbro component in oceanic areas, and material with properties of the high-pressure phase of shocked olivine rocks (dunite) containing 20 percent fayalite for the lower mantle. —MS

Schnepfe, Marian M. *See* Grimaldi, F. S. 04594

04690 **Scholl, David W.; Hopkins, David M.** Newly discovered Cenozoic basins, Bering Sea shelf, Alaska: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 10, pt. 1, p. 2067-2078, illus., 1969.

Geophysical studies over the Bering shelf have outlined three previously unknown basins, Norton basin and Pribilof and Zhemchug depressions. The Bering shelf is underlain by generally undeformed Cenozoic deposits about 1.0 km average thickness overlying a basement of Mesozoic and Paleozoic rocks. As much as 2.0 km of Cenozoic terrestrial and/or shallow neritic deposits (Paleogene and younger) occur in intrashelf basins (Bristol, Anadyr, Norton basins) under major bays and gulfs, and in narrower fault-controlled outer shelf basins (Pribilof and Zhemchug depressions) that parallel the continental margin. These basement depressions are grabens and/or half grabens; Cenozoic fill is deformed above faults that offset basement and sea floor near Pribilof Islands. —*from* Authors' abstract

Schweinfurth, S. P. *See* Kent, B. H. 04938

Seager, William R. *See* Hawley, John. 04995

04941 **Searcy, Karen B.** Variation in *Cercocarpus* in southern California: New Phytologist, v. 68, no. 3, p. 829-839, illus., 1969.

Living leaves of *Cercocarpus* (Rosaceae) are compared with fossil leaf impressions from Miocene, Pliocene, and Pleistocene floras of California and adjacent Oregon and Nevada, to interpret the present pattern of geographic variation in leaf size in southern California, where the *C. betuloides* complex of two species and three varieties are components of the chaparral. Results of growth tests on the large-leaved and small-leaved varieties indicate that differences in size and venation are primarily genetic. The fossil leaves fall into a large-leaved group resembling *C. betuloides* var. *macrourus* and a small-leaved group resembling var. *betuloides*. The modern taxa have had separate histories since at least the Miocene, remaining morphologically stable despite changes in climate and topography. —VMJ

04351 **Seguin, M. K.** Relation des phases dans le systeme Fe-C-S + (H_2O) [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 146, 1969.

04414 **Selfert, K. E.** Strength of Adirondack anorthosite at elevated temperatures and pressures: Geol. Soc. America Bull., v. 80, no. 10, p. 2053-2059, illus., 1969.

The strength of fine-grained anorthosite from AuSable Forks quadrangle in the Adirondacks was determined in triaxial compressive tests using modified Grigg's constant strain rate apparatus. The anorthosite consists of 90 to 95 percent plagioclase An_{50} in an intermediate structural state. The strength of anorthosite increases with increasing confining pressure and with decreasing temperature, ranging from 25 kb at 400°C and 14.8 kb to less than 2 kb at 1000°C and 4.4 kb for 8 percent strain. Failure was by shear fracture and cataclasis. Only albite and pericline twins were observed before and after the experiments.—*from* Author's abstract

SEPM Permian Basin Sec. *See* ElPaso Geological Society. 04359

Sharma, P. Vallabh. *See* Ghisler, Martin. 04747

04620 **Sharp, B. J.; Hetland, D. L.; Warner, R. O.** Uranium deposits in Oligocene, Miocene, and Pliocene sediments west of the Rocky Mountains [abs.]: Mining Eng., v. 21, no. 8, p. 38, 1969.

04352 **Shaw, D. M.** Trace element trends during fractional melting—Some theoretical considerations [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 146, 1969.

04848 **Shaw, D. M.** Evaluation of data, Chap. 11 *in* Handbook of geochemistry, V. 1 (K. H. Wedepohl, editor): Berlin and New York, Springer-Verlag, p. 324-375, tables, 1969.

Data on analytical errors involved in geochemical studies, statistical procedures commonly used for solution of geochemical problems, and the principles of interpretation of chemical analyses of silicates are summarized. Conversion and other tables are appended. In addition to statistical and systematic errors, sensitivity is defined as a third source of error. —MS

04550 **Shawe, D. R.; Poole, F. G.; Brobst, D. A.** Newly discovered bedded barite deposits in East Northumberland Canyon, Nye County, Nevada: Econ. Geology, v. 64, no. 3, p. 245-254, illus., table, 1969.

"Barite beds, which consist of massive and rosette barite rock and minor amounts of conglomeratic barite rock, are interlayered with dark chert and shaly mudstone of the eugeosynclinal western siliceous facies of Ordovician age. The barite rock . . . contains 71-94 percent $BaSO_4$." A sedimentary origin is indicated by radiolarian tests as nuclei for rosettes, intraformational conglomerate with barite clasts, and the association with chert, organic material, and phosphate nodules. —WSW

Sherman, Frank B. *See* Cartwright, Keros. 04742

04691 **Sherwood, W. Cullen; Huang, Jinn Huie.** Pore studies of highly indurated Appalachian rocks: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 10, pt. 1, p. 2161-2170, illus., tables, 1969.

This is a study of the volume and size of pores in carbonate, igneous, and metamorphic rocks from the Piedmont and Valley and Ridge provinces of Virginia. The pore size of carbonate rocks tends to concentrate at a single size, and the mean diameters of pores are generally smaller and have a lesser size range than igneous and metamorphic rocks. Pore size apparently varies with grain size and texture regardless of mineral composition, and 2 to 4 size concentrations are present in igneous and metamorphic rocks. Generally carbonate rocks have greater porosity than other rock types. Apparently dolomitization in this region preceded compressive forces of the Appalachian folding. —SEF

Shido, Fumiko. *See* Miyashiro, Akiho. 04688

Shido, Fumiko. *See* Miyashiro, Akiho. 04764

04992 **Shieh, Y. N.; Taylor, H. P., Jr.** Oxygen and carbon isotope studies of contact metamorphism of carbonate rocks: Jour. Petrology, v. 10, no. 2, p. 307-331, illus., tables, 1969.

Variations in O-18/O-16 and C-13/C-12 ratios resulting from contact decarbonation reactions are discussed on the basis of analysis of carbonate rocks and coexisting minerals from contact metamorphic aureoles at Birch Creek, Calif., and Marble Canyon, Tex. A consistent order of enrichment in the ratios was observed in the coexisting minerals. Oxygen and carbon isotope fractionations in coexisting dolomite and calcite exhibit a relationship but no obvious correlation with sample distance from the contact. Other observations are reported, and it is noted that the data indicate that the CO_2 liberated during the decarbonation process is enriched in both O-18 and C-13 relative to the carbonates. —MS

04353 **Shimazaki, H.** Synthesis of a copper-iron disulfide phase [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 146, 1969.

04816 **Shimp, N. F.; Witters, J.; Potter, Paul Edwin; Schleicher, J. A.** Distinguishing marine and freshwater muds: Jour. Geology, v. 77, no. 5, p. 566-580, illus., tables, 1969.

Eighty-two modern marine and freshwater mud samples were analyzed for B, Cr, Ga, Ni, V, total clay ($<2\mu$), different clay minerals, $CaCO_3$, and organic carbon. Thirteen variables were statistically evaluated to distinguish marine from freshwater muds. Results show that B has a very high correlation with the amount of clay, and for a given clay content the marine muds contain 30-45 ppm more B than freshwater muds. Further, the data support the conclusion of others that B in marine muds increases progressively seaward from a strandline as the amount of total clay increases. If a single environmental differentiator is used, B is superior to clay content. Statistically, the other components cannot be used effectively, singly or in groups, as environment indicators. —*from* Authors' abstract

Shor, George G., Jr. *See* vonHuene, Roland E. 04429

04984 **Shreve, Ronald L.** Stream lengths and basin areas in topologically random channel networks: Jour. Geology, v. 77, no. 4, p. 397-414, illus., tables, 1969.

The author demonstrates, through the use of topology, that elementary quantities such as link lengths and source areas are of more fundamental significance than Horton variables in the study of the geometry of drainage basins and channel networks. —FSF

04497 **Shurbet, D. H.** Excitation of Rayleigh waves: Jour. Geophys. Research, v. 74, no. 22, p. 5339-5341, illus., 1969.

Rayleigh waves recorded at Lubbock, Texas, from natural earthquakes and from nuclear explosions are compared. Natural earthquakes generate both first-mode and second-mode Rayleigh waves, but the explosions generate only first-mode Rayleigh waves. Absence of second-mode Rayleigh waves from the explosions is related to a lack of SV energy in the source mechanism. —Author's abstract

04923 **Shute, John; Ball, Arthur.** A. J. F. Stone (1917-1969): Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 2018, portrait, 1969.

04798 **Sikander, A. H.; Fyson, W. K.** Structural development of the Paleozoic rocks of western Gaspé, Quebec: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1113-1127, illus., table, 1969.

Cambro-Ordovician greenschists and phyllites in the Shickshock Mountains area are characterized by a foliation S_1 almost completely parallel to layering, and mineral lineation axial to obscure tight folds F_1. Dominant folds F_2, affecting all Lower and Middle Paleozoic rocks, trend northeast and include the Gaspé synclinorium. Discontinuous folds F_3, exposed only in Ordovician rocks on the north coast, have steep axial surfaces striking eatward. Small kinks, F_4, virtually restricted to Shickshock Schists with S_1, form conjugate sets with steep to vertical northwest-trending kink planes. Later (?) kink bands in Devonian argillites displace steep S_2 subhorizontally. Strain during F_1 folding is not clear; F_2, F_3, and F_4 possibly formed during near horizontal compression. —*from* Authors' abstract

Silvester, R. *See* Brotchie, J. F. 04599

Simmons, W. B., Jr. *See* Allard, G. O. 04403

04778 **Simon, Ruth B.** Seismicity of Colorado—Consistency of recent earthquakes with those of historical record: Science, v. 165, no. 3896, p. 897-899, illus., tables, 1969.

Earthquakes instrumentally recorded from 1966 to 1968 have occurred in the same regions of western Colorado, the Arkansas and Platte River valleys, as those felt back to 1870 (from newspaper reports), despite the increasing cultural effects of mining, highway construction, reservoir building, and loading. Thus it appears unnecessary to explain the Denver earthquakes in terms of pressure induced by the introduction of waste fluid. However, the assumption of pre-existent tectonic strains in the area of the Rocky Mountain Arsenal seems to be confirmed. —Author's abstract

Simons, Daryl B. *See* Komura, Saburo. 04503

04946 **Simons, Frank S.** Exploration aspects of the U.S. Geological Survey's heavy-metals program, *in* Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, p. 4-6, 1969.

The main thrust of this program has been toward gold. The program is not designed to find ore deposits but only to identify potential targets for examination by the mineral industry. The bulk of the effort so far has been in areas already known to contain gold deposits. Examples are cited whereby more detailed work in these regions has shown new potentials for examination. Included are the Homestake area in South Dakota; Goldfield and Virginia City, Nevada; the Sierra Nevada region of California; and the Klamath Mountains region of Oregon and California. New exploration ideas and techniques have been applied to these regions and new potential sources have been suggested. —HRC

Simons, J. G. *See* Lambert, R. StJ. 04972

Simpson, Ruth D. *See* Leakey, Louis S. B. 04459

04850 **Sims, P. K.; Morey, G. B.; Green, J. C.** The potential for new mineral discoveries in Minnesota, *in* Mining Symposium, 30th Ann., and AIME, Minnesota Sec., 42d Ann. Mtg., Duluth, Minn., 1969: Minneapolis, Minn., Univ. Minnesota, School Mineral and Metall. Eng., p. 75-87, illus., 1969.

Minnesota contains two geologic environments, besides the iron-formations, that are favorable for the occurrence of metallic ore deposits: the Duluth Complex in the northeast, and Keewatin greenstone belts in the north. The Complex, a composite intrusive body of Keweenawan age, is one of the major potential reserves of copper and nickel in the world. Recently a titanium-iron oxide body was also delineated. Locally serpentinized peridotite bodies occur in the belts extending across northern Minnesota. Resemblance to mining districts in Ontario and Quebec make the belts warrant consideration for exploration for massive sulfides and gold-vein deposits. The western Gunflint range, adjacent to the Duluth Complex, is considered a potential source of taconite. —ESL

04354 **Sinha, R. P.; Friedlaender, C. G. I.** Petrology of volcanic rocks of North Mountain, Nova Scotia [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 146-147, 1969.

04355 **Skippen, G. B.** An experimental model for the metamorphism of siliceous carbonates [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 147, 1969.

04728 **Smiley, Charles J.** Floral zones and correlations of Cretaceous Kukpowruk and Corwin Formations, northwestern Alaska: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 10, pt. 1, p. 2079-2093, illus., tables, 1969.

Plant megafossils in the Kukpowruk River-Corwin Bluff areas suggest early Albian to Cenomanian age for the Kukpowruk and Corwin Formations. In the Corwin type section, three sequential floral zones are: (1) oldest, equivalent largely to the Torok Formation; (2) middle, found also in the Kukpowruk and lower part of the Corwin in Kukpowruk River area and in the Tuktu Formation of Chandler-Colville area, 300 miles east; (3) youngest, correlative with middle Corwin units in Kukpowruk River area and with lower part of the Killik tongue of Chandler Formation in Chandler-Colville area. Plants in upper Corwin beds along Kukpowruk River represent a floral zone younger than those described above. The uppermost member in the Corwin type section of Chapman and Sable (1960) is a structural duplication of older beds. —*from* Author's abstract

Smith, D. H. *See* Wampler, J. M. 04870

Smith, J. A. *See* Johnson, S. W. 04516

Smith, J. V. *See* Knowles, C. R. 04986

04730 **Smith, R. B.; Warnock, J. E.; Stanley, W. D.** Computer graphics in geophysical interpretation and data representation [abs.]: Mining Eng., v. 21, no. 8, p. 42, 1969.

Smith, V. C. *See* Dodge, F. C. W. 05002

04740 **Smith, Wilbur H.; John, Edward C.** More jobs for geology spur better mapping methods at Bingham Canyon: Mining Eng., v. 21, no. 9, p. 93-94, illus., 1969.

Base maps for mapping pit geology in the Bingham Canyon copper mine are now prepared photogrammetrically twice a year and are updated more often where necessary. Geological data entered on the maps in the field include structure, rock type, alteration, sulfide mineral distribution, and others. Field data sheets are designed so that the field information can be readily entered into computer programs for automatic processing and plotting of the data. —MAC

Sood, M. K. *See* Platt, R. G. 04371

04974 **Sörensen, H.** Field work in the Ilimaussaq intrusion, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 37-38, 1969.

Four types of uranium deposits have been established: (1) a zone of contact alteration around late veins and sheets of medium- to coarse-grained lujavrite, (2) syenites, naujaite, gabbro, lavas, etc. of the region are veined by fine-grained lujavrites which locally contain more than 300 ppm U, (3) zones of deformation in gabbro and lava which are permeated by fine-grained lujavrite and also by veins of (2) above, and (4)

a body of brownish-green lujavrite, in part naujakasite-bearing, which is cut by pegmatitic veins of the type (1) above. —HRC

Sorensen, J. M. *See* Jansen, G. J. 04555

04990 **Spencer, Alexander B.** Alkalic igneous rocks of the Balcones province, Texas: Jour. Petrology, v. 10, no. 2, p. 272-306, illus., tables, 1969.

The Cretaceous sills, laccoliths, and other alkalic rock masses of the Balcones igneous province were derived from separate primary basaltic and nephelinitic magmas whose emplacement was apparently localized by transverse structural features of the buried Ouachita structural belt underlying the intruded Mesozoic coastal plain sediments. Differentiation of the nephelinitic magmas involved two independent fractionation trends with melilite-olivine nephelinite and analcime phonolite (from nepheline basanite) as end products. Descriptions of rock types (with tabulated data on modes, chemical compositions, and norms), as well as component and accessory minerals, are included. —MS

Sproule, J. C. *See* Layer, D. B. 04921

04468 **Stalker, A. MacS.** A probable late Pinedale terminal moraine in Castle River valley, Alberta: Geol. Soc. America Bull., v. 80, no. 10, p. 2115-2122, illus., tables, 1969.

Radiocarbon dates from the Castle River Valley of southwestern Alberta indicate that the last major glacier advance down that valley reached its maximum extent 6200 radiocarbon years ago. This advance is considered to be late Pinedale in age. The Pinedale then ended with onset of the "Climatic Optimum" or "Altithermal," which lasted in that region from about 6000 to 4500 years B.P. The dates were obtained on bison bones found in outwash near the base of a 250-ft-high cliff. —*from* Author's abstract

04657 **Stanley, A. D.** Observations of the surge of Steele Glacier, Yukon Territory, Canada, *in* Seminar on the causes and mechanics of glacier surges, St. Hilaire, Quebec, 1968: Canadian Jour. Earth Sci., v. 6, no. 4, pt. 2, p. 819-829, illus., tables; discussion, p. 829-830, 1969.

During 1966, the glacier moved at a rate exceeding 500 m per month, and by 1968 had slowed to less than one tenth the rate. For most of the 35 km length of the main trunk, the surface was a chaotic jumble of ice blocks, spires, and pinnacles, but large structures, outlined by surface moraine, were preserved. Displacement suggests that most of the glacier moved forward as a block. The surge has not been correlated with any earthquake activity, and there is no evidence of a short-term climatic change. The movement is considered to result from critical dynamic conditions within the glacier, possibly facilitated by increased amounts of water along the ice-bedrock contact. —*from* Author's abstract

Stanley, W. D. *See* Smith, R. B. 04730

Steinnes, E. *See* Michelsen, O. B. 04637

04737 **Stephens, J. D.; Wittkopp, R. W.** The microprobe and the mineral industries [abs.]: Mining Eng., v. 21, no. 8, p. 44, 1969.

Sterling, D. A. *See* Malan, R. C. 04621

04658 **Stevens, Calvin H.** Water depth control of fusulinid distribution: Lethaia, v. 2, no. 3, p. 121-132, illus., 1969.

Detailed field study of a thin sequence of Middle Pennsylvanian rocks in central Colorado, unit 13 of the Minturn Formation, indicates that juvenile fusulinids were occasionally swept into water as shallow as 4 meters, but that few survived to maturity in water with a depth of less than 13 meters. These depth figures are based upon: knowledge of the form of the surface upon which marine beds representing max-

imum transgression were deposited; the conclusion that distribution of many faunal and floral groups in central Colorado was controlled by factors directly affected by depth. —*from* Author's abstract

Stevens, R. K. *See* Williams, Harold. 04677

04943 **Stevenson, D. L.; Dickerson, D. R.** Organic geochemistry of the New Albany Shale in Illinois: Illinois Geol. Survey Illinois Petroleum 90, 11 p., illus., 1969.

The Mississippian-Devonian New Albany Shale was sampled over a 35,000 sq mi area in the southern two-thirds of Illinois. Samples were subjected to an organic geochemical investigation to determine their qualities as petroleum source rocks. In the very dark-colored bottom 50 feet of this shale, organic carbon content averages slightly over 4 percent by weight. Benzene soluble compounds make up as much as 0.2 percent of the weight of the rock. Total volume of benzene extractable compounds in the bottom 50 feet of shale is 50×10^9 bbl, which is 100 times more than the total volume of oil found in the underlying Devonian-Silurian reservoirs. The organic geochemical data suggest the New Albany Shale as a likely source of most of the Devonian-Silurian oil in Illinois. —*from* Authors' abstract

04746 **Stewart, Glenn W.** Drilled water wells in New Hampshire: New Hampshire Dept. Resources and Econ. Devel. Mineral Resources Survey, pt. 20, 51 p., illus., tables [1969,].

Data collected in both of two drilled-well surveys in New Hampshire, principally depth of well, yield, and depth to bedrock, with some of drillers' brief notes on type of surface materials and bedrock, are on file in the Office of the State Geologist in Durham. Listed by town in the appendix of this report, they are evaluated and interpreted for use as guides to water supplies and subsurface conditions. The occurrence of ground water, its movement, and the significance of jointing relative to surface and bedrock topography are reviewed; a map shows some well locations and types of rocks. A tabulation of this author's data from over 6000 wells, published in a brief summary of the second survey (1964), is reprinted in this appendix. —GDC

Stewart, J. M. *See* Petruk, W. 04384

04808 **Stewart, John H.** Major Upper Triassic lithogenetic sequences in Colorado Plateau region: Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 1866-1879, illus., 1969.

The *bentonitic* sequence consists of variegated bentonitic claystone, clayey sandstone, and thin widespread sandstone and conglomerate units. Sediments were derived mostly from a volcanic source area to the south, the Mogollon highland, and were deposited in streams and lakes and on floodplains. The overlying *redbed* sequence consists of horizontally stratified siltstone and minor limestone and sandstone, is mostly lacustrine, and was derived from several source areas of which the Uncompahgre and Front Range highlands of Colorado may have been the main ones. The overlying *sandstone* sequence is cross-stratified sandstone believed to be of aeolian origin, probably derived from reworking of sands northwest of the region. —*from* Author's abstract

04463 **Stieglitz, Ronald D.** Surface textures of quartz and heavy-mineral grains from freshwater environments—An application of scanning electron microscopy: Geol. Soc. America Bull., v. 80, no. 10, p. 2091-2094, illus., 1969.

Sand grains can be prepared more quickly and more surface of each grain is accessible for observation with the scanning electron microscope than with the transmission electron microscope. The scanning electron microscope reveals more relief on quartz sand grains than does the transmission electron microscope. Clastic heavy mineral grains have some surface features that can be related to mineralogy. —WHN

Stokes, William Lee. *See* Balsley, John K. 04794

04795 **Stone, Donald S.** Wrench faulting and Rocky Mountain tectonics: Earth Sci. Bull., v. 2, no. 2, p. 27-41, illus., tables, 1969.

Wrench faults are nearly vertical fractures characterized by important lateral slip, and formed under regional compression. A genetic explanation for these compressional structures, so common in the Rocky Mts., is provided by wrench-fault tectonics. Four fundamental principles are inferred from the block diagrams used to illustrate wrench fault characteristics; 12 characteristics are discussed and listed. Second order or wrench faulting arising from redistribution of stress accompanying movement on a master fault is described. Application of this concept to tectonics of the central Rocky Mts. indicates that wrench faulting is more prevalent than supposed. Many wrench fault characteristics can be recognized in the central Rocky Mtn. foreland area. Three generalizations with significance in mineral exploration are given. —ESL

Strain, William S. *See* Hawley, John. 04995

04999 **Strain, William S.** Late Cenozoic strata of the El Paso area, *in* Border stratigraphy symposium—AAAS S.W. and Rocky Mtn. Div., 44th Ann. Mtg., El Paso, Tex., 1968: New Mexico Bur. Mines and Mineral Resources Circ. 104, p. 122-123, 1969.

The Hueco and Mesilla bolsons were the prominent basins of deposition in the El Paso area. Initially they were separate, but they were filled and the sediments then formed a blanket in the area, deposited in Lake Cabeza de Vaca. The Fort Hancock Formation, at least 350 feet thick but possibly thousands, is composed of bentonitic claystone, siltstone, and silt. This is disconformably overlain by the Camp Rice Formation, at the surface, which is composed of gravel, sand, silt, volcanic ash, and caliche. The Camp Rice was deposited fluvially following drainage in Kansan time of the lake in which the Fort Hancock was deposited. Recent investigations suggest that these two formations have a genetic relationship to the underlying Santa Fe Group and should be included with the other formations in the group. —HRC

04719 **Stringfield, V. T.; LeGrand, H. E.** Hydrology of carbonate rock terranes—A review, with special reference to the United States [Pt. 1]: Jour. Hydrology, v. 8, no. 3, p. 349-376, illus., 1969.

Carbonate rocks have many unusual features and extreme conditions involving hydrology; there may be little agreement as to what is typical or average for such features as soil thickness, permeability, and karst. Many problems are resolvable only by careful geologic and hydrologic studies. The concept that secondary permeability is developed by circulating ground water enlarging openings is generally accepted in limestone terranes, but emphasis in published reports is on relative hydrogeologic framework or geologic setting. The solution openings, developed commonly in the upper zone of saturation, become air-filled caverns as base level and water table are lowered. Reconstruction of geologic and hydrologic history of a limestone aids in determining the extent and positions of fossil and present permeability. —GDC

Stringfield, Victor T. *See* LeGrand, Harry E. 04560

04558 **Stumpfl, E. F.** Determining fineness variation characteristics in gold ores by reflectometry [discussion of paper by H. V. Eales, 1967]: Econ. Geology, v. 64, no. 3, p. 341-342, 1969.

Reliability of method described by Eales (ibid., v. 63, no. 6, p. 688-691, 1968) is questioned because of quality of standards and the problems of homogeneity of standards, effect of impurities such as copper, and quality of specimen preparation. —WSW

04548 **Sturman, B. D.** Use of the diagram: Econ. Geology, v. 64, no. 4, p. 464-465, illus., 1969.

An apparent-dip diagram can also be used to determine the attitude of lines and planes with respect to a cross-section. —WSW

04869 **Sudarsanan, K.; Young, R. A.** Significant precision in crystal structural details —Holly Springs hydroxyapatite: Acta Cryst., v. B25, pt. 8, p. 1534-1543, illus., tables, 1969.

Precision with which crystal structural details can be obtained with routine procedures has been assessed and illustrative applications to analyses of bonding effects and of impurity substitutions have been made. Least-squares refinements with X-ray and neutron diffraction data for three hydroxyapatites yielded $R \simeq 2$ percent in each case. Minor extinction corrections improved the mutual agreement among separate measures of some parameters. Final results were insensitive to reasonable changes in weighting. Comparison of X-ray and neutron results showed systematic differences associated with oxygen atoms bonded to phosphorus in the phosphate group. Analysis of final R value suggested real differences among crystals smaller than σ's associated with individual parameters, and either a systematic inadequacy of refinement model, or similar residual systematic errors in both data sets. —*from* Authors' abstract

Swanson, Mary. *See* Emiliani, Cesare. 04777

04674 **Swindle, George; vanAndel, Tjeerd H.** Computer contouring of deep sea bathymetric data: Marine Geology, v. 7, no. 4, p. 347-355, illus., 1969.

A computer program has been used to construct a contour map of the crest of the Mid-Atlantic Ridge between 22° and 23° N. The computer map is produced more efficiently than a manually contoured chart and yields an acceptable representation of sea-floor topography free of interpretative bias [except for any bias built into the program itself]. In this case, this bias is expressed as a pronounced linearity of topographic elements shown on the manually contoured chart. The program is outlined in brief. It can be used without change for contouring other than bathymetric data. —Authors' abstract

04963 **Symons, D. T. A.** Paleomagnetism of the late Miocene plateau basalts in the Cariboo region of British Columbia: Canada Geol. Survey Paper 69-43, 16 p., illus., tables, 1969.

A paleomagnetic study was made on 251 cores from 49 flows representing several stratigraphic sections of undisturbed olivine-rich plateau basalts in the Cariboo region. Alternating-field demagnetization was used to isolate primary thermomagnetic remanence of cores. Statistical analysis of remanence directions indicates the basalts were extruded over a time interval of 2-5 m.y.; they emanated from numerous volcanic vents in local accumulations which formed rapidly within one polarity interval. The derived pole position of 140.3° W., 84° N. is consistent with: late Miocene (14-10 m.y.) age indicated by radiometric and paleontologic evidence; the pole derived from four gabbroic plugs which apparently occupy the original volcanic vents; and the pole derived from Columbia River basalts which indicate the flows have not been subjected to regional tectonic rotation. —*from* Author's abstract

Symons, D. T. A. *See* Christie, K. W. 04967

Szabo, B. J. *See* Rosholt, J. N. 04628

04901 **Szasz, Stephen E.; Adent, William A.; Fantozzi, Joseph H.** Special development problems of Long Beach unit, Wilmington field: Oil and Gas Jour., v. 67, no. 30, p. 195-202, illus., 1969.

Wilmington, one of several major oil fields in the Los Angeles basin, contains about 70 producing zones in formations of Miocene and Pliocene age. Structure is a NW-SE trending anticline broken by a complex system of mainly transverse faults. Shifts of the axial plane between fault blocks and with depth, variations in petrophysical characteristics, and large differences between the water tables indicate a very complex depositional and postdepositional history. About 700 wells are planned in the Long Beach unit which includes most of the offshore part of the field. —HHA

04660 **Tabor, R. W.; Crowder, D. F.** On batholiths and volcanoes—Intrusion and eruption of late Cenozoic magmas in the Glacier Peak area, North Cascades, Washington: U.S. Geol. Survey Prof. Paper 604, 67 p., illus., tables, geol. map, 1969.

The three principal episodes of Cenozoic igneous activity in the Glacier Peak area were: intrusion of the tonalite-granodiorite Cloudy Pass batholith in early Miocene (K-Ar age, 22 m.y.); the extrusion between early Miocene and Pleistocene of thick andesitic to dacitic breccia, tuff, and lava of Gamma Ridge on and near the batholith; and, in late Pleistocene and Recent, the growth of the dacitic Glacier Peak volcano, accompanied by eruption of basalt from separate vents near the Peak. The geologic setting and age, structure, lithology, and intrusion and differentiation are discussed for the Cloudy Pass batholith, and the general features, age, and petrology are examined for the volcanic episodes. Regional structural features that guided late Cenozoic magmas are summarized. —VSN

04868 **Tailleur, Irv.** Speculations on North Slope geology, Pt. 1: Oil and Gas Jour., v. 67, no. 38, p. 215-220, 225-226, illus.; Pt. 2, ibid., no. 39, p. 128-130, illus., 1969.

This article summarizes the geologic development of northern Alaska as follows: sedimentation off land to the north into a basin covering most of northern Alaska from Devonian into Jurassic time; a tectonic welt with complementary foredeeps and successor basins forming within the older basins in Jurassic and Cretaceous time; rocks within part of the welt foreshortening to as little as half their original width before latest Early Cretaceous time; and the welt and basins deforming into the fold belt of the present Brooks Range and foothills in Late Cretaceous or Tertiary time. Growth of the tectonic welt may have resulted from the rotation and drift of crustal blocks. The Siberian-Alaskan and the Canadian Arctic Archipelago blocks may have rotated apart as the Canada basin of the Arctic Ocean rifted open after the Triassic. —*from* Author's summary

Takahashi, H. *See* Higuchi, H. 04624

04932 **Takahashi, Taro; Mao, Ho Kwang; Bassett, W. A.** Lead—X-ray diffraction study of a high pressure polymorph: Science, v. 165, no. 3900, p. 1352-1353, illus., table, 1969.

An X-ray diffraction study of lead under pressure has shown that the face-centered cubic structure transforms to the hexagonal close-packed structure at room temperature and a pressure of 130 ± 10 kilobars. The volume change for the transformation is -0.18 ± 0.06 cubic centimeter per mole. —Authors' abstract

Tamrazyan, G. P. *See* Ovnatanov, S. T. 04720

04544 **Tarutani, Toshikazu; Clayton, Robert N.; Mayeda, Toshiko K.** The effect of polymorphism and magnesium substitution on oxygen isotope fractionation between calcium carbonate and water: Geochim. et Cosmochim. Acta, v. 33, no. 8, p. 987-996, illus., tables, 1969.

Calcite, aragonite and magnesian calcite were slowly precipitated from aqueous bicarbonate solutions, and oxygen isotope fractionation factors between the precipitate and water were measured. For calcite-water at 25°C and 0°C, $1000 \ln \alpha =$ 28.1 and 33.7, respectively, both values in excellent agreement with the Urey-Epstein paleotemperature scale. Aragonite-water at 25°C gave 28.7, implying a small but significant fractionation between aragonite and calcite. O-18 also concentrates in magnesian calcite, relative to pure calcite precipitated under the same conditions, by 0.06 per mil for each mole-percent $MgCO_3$ in calcite. —Authors' abstract

Tauber, Henrik. *See* Dansgaard, W. 04856

04553 **Taylor, Charles M.; Radtke, Arthur S.** Micromineralogy of silver-bearing sphalerite from Flat River, Missouri: Econ. Geology, v. 64, no. 3, p. 306-318, illus., tables, 1969.

Samples of silver-rich sphalerite were studied by optical microscopy, electron-microprobe analysis, and X-ray diffraction. Ag, Cd, and to a lesser degree Fe all vary directly with chlorine. Since chloride ion should not substitute significantly for sulfide in sphalerite, and it does not in ZnS synthesized in chloride solution, it seems unlikely that the Ag is present as chloride. Submicron-size grains of a complex chloride or oxychloride are a possibility. Dusty inclusions in sphalerite are mostly galena with minor pyrite and cassiterite. Galena is pure and silver-free. Other minerals include Co-Ni-Fe sulfides. —WSW

Taylor, H. P., Jr. *See* Shieh, Y. N. 04992

Taylor, Hugh P., Jr. *See* Conway, Clay M. 04805

Taylor, J. W. *See* Voight, Barry. 04760

04900 **Taylor, S. R.; Levinson, A. A.** (editors). Geochemistry of tektites—Introduction—Internat. Tektite Symposium, 3d, Corning, N.Y., 1969: Geochim. et Cosmochim. Acta, v. 33, no. 9, p. 1013-1014, 1969.

A total of 46 papers were presented at the Third International Tektite Symposium held at Corning, New York, on April 16-18, 1969. The ultimate importance of these papers (13 of which are published in this issue of Geochima et Cosmochimica Acta) is that they represent the final positions adopted by the scientific community on the tektite problem prior to the receipt of the lunar samples. The paper by Wampler, Smith, and Cameron is cited separately. —DBV

Taylor, W. H. *See* Ribbe, P. H. 04904

Teal, D. J. *See* Johnson, S. W. 04516

Tera, F. *See* Peterson, S. F. 04716

Termier, Genevieve. *See* Termier, Henri. 04965

04965 **Termier, Henri; Termier, Genevieve.** Les stromatocystitoïdes et leur descendance —Essai sur l'évolution des premiers echinodermes [with English abs.]: Geobios, no. 2, p. 131-156, illus., 1969.

Species of the Cambrian echinoderm genera *Stromatocystites*, *Cambraster*, and *Eikosacystis* are redescribed; Stromatocystitoidal n. order, and three families, Stromatocystitidae Bassler, 1936, emend., Cambrasteridae, n. fam., and Eikosacystidae, n. fam., are proposed. The oldest known species is *S. walcotti* Schuchert, 1919, from the Lower Cambrian of Newfoundland; the type species from Bohemia, and the six species of the other two genera, all from France, are Middle Cambrian. It is suggested that the most primitive stromatocystitoids, showing beginnings of ambulacral appendages, gave rise, mainly in North America, to the sessile edrioasteroids; in Europe they evolved, through *Cambraster*, toward the asterozoans and, through *Eikosacystis*, toward the homalozoans (carpoids). —VMJ

04443 **Thill, R. E.; Willard, R. J.; Bur, T. R.** Correlation of longitudinal velocity variation with rock fabric: Jour. Geophys. Research, v. 74, no. 20, p. 4897-4909, illus., tables, 1969.

Comparisons of longitudinal wave velocity with structural subfabrics have been made for Yule marble, Newberry Crater pumice, and Salisbury granite. Velocities were measured omnidirectionally in spherical specimens by an ultrasonic pulse technique and plotted and contoured on equal area nets. Microstructural subfabrics were determined from oriented thin sections of the specimens. The longitudinal velocity symmetry in Yule marble appears to be axial, whereas in both Newberry Crater pumice and Salisbury granite the pattern is orthorhombic. The pattern of longitudinal velocity anisotropy is associated with preferred orientation of calcite optic axes in Yule marble, preferred orientation of elongate vesicles in the Newberry Crater pumice, and preferred orientation of microfractures in quartz in the Salisbury granite. —*from* Authors' abstract

Thomas, Carroll M. *See* Jacka, Alonzo D. 04482

04879 **Thomas, Charles W.** Paleontological analyses of North Pacific ocean-bottom cores: Pacific Sci., v. 23, no. 4, p. 473-482, illus., tables, 1969.

Three North Pacific ocean-bottom cores were studied: No. 1, from the rim of the Aleutian Trench, south of Attu Island; No. 2, about 140 miles south of Attu; No. 8, from the Marcus-Necker Ridge near Johnston Island. The upper 40 cm of core No. 1 is almost entirely organic material; the remaining 275 cm is mostly glacial marine sediments. Climatic conditions and source of clastics are inferred. Core No. 2 was of virtually no stratigraphic value, owing to reworking of sediments. The upper 200 cm of core No. 8 was analyzed, dated, and correlated with other low-latitude cores, with core No. 1, and with cores from the central Arctic Ocean. A pelagic foraminifer generally believed to be Tertiary was found with Pleistocene foraminifers. The analyses confirm the basic premise of the Ewing and Donn theory of ice ages, and suggest that stadial intervals are mainly ones of slow glacial wastage. —*from* Author's abstract

Thomasson, M. Ray. *See* Thomson, Alan. 04536

04652 **Thompson, Allan McMaster.** Sedimentologic and geochemical studies of the Bald Eagle-Juniata color boundary, central Pennsylvania [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 261B-262B, 1969.

04925 **Thompson, Alvin J.** Plan for aiding exploration and development of New Mexico's mineral resources, *in* Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, p. 112-113, 1969.

The New Mexico Bureau of Mines and Mineral Resources has published bulletins on the mineral resources of seven counties; numerous special reports on particular mineral resources have appeared also. Geology and ground-water reports have been completed for ten counties, and it is proposed that the state support geophysical surveys of the areas that appear to offer the most promise of subsurface wealth. It is anticipated that to complete this program of studies for the entire state in the course of a five-year period would require about one-half million dollars per year. Since this is equal to about 0.06 percent of the value of the state's annual mineral production, it seems reasonable to believe that the appropriations would yield returns far out of proportion to the amount received. —HRC

04916 **Thompson, Fred M., Jr.; Buck, Cleo E.** Dale L. Benson 1899-1968): Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 2010, portrait, 1969.

Thompson, R. M. *See* Drummond, A. D. 04364

Thomson, Alan. *See* McBride, Earle F. 04533

04535 **Thomson, Alan.** Soft-sediment faults in the Tesnus Formation and their relationship to paleoslope, *in* A guidebook to the stratigraphy, sedimentary structures and origin of flysch and pre-flysch rocks of the Marathon basin, Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 72-77, illus., 1969.

Deformational features of pre-consolidation origin are present, such as rolled sandstone bodies, sandstone dikes, diapiric structures, and normal faults of small displacement. The fault throws are less than one inch and average 1/4 inch, and intersect the base of the beds at an average of 55°, whereas post-consolidation fractures are normal to the base. Statistically, the faults tend to parallel the paleoslope contours, and over 95 percent were downthrown down the paleoslope. Each fault has a zone less than 1 mm wide, and the soft-sediment origin is shown by: (1) the lack of sharp fault-zone-country rock boundaries; (2) the absence of fractured grains in the fault zones, and (3) fault zones cut by healed fractures of post-consolidation origin. They are useful for determining current directions for sole markings. —HRC

04536 **Thomson, Alan; Thomasson, M. Ray.** Sedimentology of the Dimple Limestone, Marathon region, Texas, *in* A guidebook to the stratigraphy, sedimentary structures

and origin of flysch and pre-flysch rocks of the Marathon basin, Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 78-85, illus., 1969.

This Early Pennsylvanian formation is a NE-SW trending, 200 to 905 feet thick sequence of limestone, shale, conglomerate and chert which can be referred to shelf, slope, and basin facies. The shelf facies is a band of limestone paralleling the north and northwest margins, typically of nongraded fossil and oolith grainstones cemented by sparry calcite. The slope facies parallels the shelf and consists of limestones which are typically nongraded and cross-laminated in the lower parts and graded, laminated, and convoluted in the upper parts. The basin facies is most widespread and is composed of graded limestones which grade into the slope limestones. The shelf rocks are high-energy shallow-water deposits and directional structures show paleocurrents flowed down a gentle slope from the north and northwest. —HRC

Thomson, Alan. *See* McBride, Earle F. 04541

04426 **Thomson, Kenneth.** Sugar Loaf, *in* The Ordovician symposium—El Paso Geol. Soc., 3d Ann. Field Trip, 1969: El Paso, Tex., El Paso Geol. Soc., p. 143-144, 1969.

The Franklin Mountains have been described as a tilted horst block. Sugar Loaf is the southernmost part of the primary downthrown block. Two major longitudinal faults are found on the dip slope of Sugar Loaf. In addition to the intense faulting of the downthrown block, the strata become progressively more fractured from north to south, with the grestest intensity in the Sugar Loaf area. —KAF

04753 **Thorén, Ragnar.** Picture atlas of the Arctic: Amsterdam, Netherlands, and New York, Elsevier Publishing Co., 449 p., illus., 1969.

This book, touching on all sciences with the exception of zoology and botany, deals mainly with regions north of the Arctic Circle. The air and ground photographs are located and interpreted from various points of view. Photographs for each Arctic area are preceded by a text that includes information on mineral resources, general physiography, and glacial geology. In addition to chapters on the Arctic Ocean and drifting ice stations, the book contains chapters on the arctic region of Alaska, the Canadian Arctic, Greenland, Iceland, Norwegian islands in the Arctic, arctic Scandinavia, and the Societ Arctic. An extensive bibliography and an index are included. —MCM

04485 **Thornburn, Thomas H.** Geology and pedology in highway soil engineering, *in* Reviews in engineering geology, V. 2 (D. J. Varnes and George Kiersch, editors): Boulder, Colo., Geol. Soc. America, p. 17-57, illus., 1969.

Proper roadway design requires the use of every available aid in order to relate a small amount of test and pavement performance data to the largest possible mass of earth. The principal sources of such assistance are geologic and soil reports. Significant progress has been made in the correlation of geologic, pedologic, and air photo map units with engineering characteristics of soils, and through the use of statistical methods, some measure of the variability of natural soils is obtained. The statistical correlation of quantitative engineering data with map units is still in its infancy, but it gives promise of providing a rational basis for the design of highway pavements. This review is primarily a discussion of the development of procedures of engineering soil survey and classification which rely upon geology, pedology, and air photo interpretation. —*from* Author's abstract

Thurston, W. R. *See* Johnson, Ross B. 05008

04441 **Tilling, Robert I.; Gottfried, David.** Distribution of thorium, uranium, and potassium in igneous rocks of the Boulder batholith region, Montana, and its bearing on radiogenic heat production and heat flow: U.S. Geol. Survey Prof. Paper 614-E, p. E1-E29, illus., tables, 1969.

Thorium and uranium abundances in igneous rocks from the Boulder batholith region generally increase with increasing SiO_2 content and decreasing $CaO/(Na_2O +$

K_2O). The average radioelement content of the batholith, weighted according to areal abundance of constituent rocks, is 3.3 percent K, 15.4 ppm Th, and 3.9 ppm U. Compared with selected igneous suites, the pre- and postbatholith volcanic rocks and the batholith rocks have thorium and uranium distributions typical of calc-alkalic suites. The distribution patterns for thorium and uranium of any comagmatic igneous suite can be grossly correlated with its 'lime-alkali' (Peacock) index. Evaluation of heat flow at Butte, radiogenic heat production, and limited geophysical data indicate that the content of heat-producing elements decreases with depth. —RIT

Timko, Donald J. *See* Overton, Harold L. 04741

Tippett, M. C. *See* Sayers, R. W. 04867

Tomura, K. *See* Higuchi, H. 04624

Tooms, J. S. *See* Cronan, D. S. 04580

04361 **Totten, S. M.** Overridden recessional moraines of north-central Ohio: Geol. Soc. America Bull., v. 80, no. 10, p. 1931-1945, illus., table, geol. maps, 1969.

The classic arcuate end moraines of north-central Ohio are veneered with from one to three Woodfordian (late Wisconsinan) tills and probably predate the last glacial episode. The elements of different ages may be distinguished by stratigraphic relations, trend directions and sharpness of topography. The end moraines are multiple, and additional end morainic elements are present in areas formerly mapped as ground moraine. In the Scioto basin 27 morainic elements can be distinguished and traced northeastward into the Killbuck basin. Similarity of form, pattern and topographic expression suggests they are recessional moraines of a single deglaciation. The presence of Millbrook Till at the base suggests the moraines are pre-Woodfordian, probably Altonian, and therefore do not mark Woodfordian till boundaries. —*from* Author's abstract

04425 **Tourtelot, Harry A.; Rye, Robert O.** Distribution of oxygen and carbon isotopes in fossils of Late Cretaceous age, western interior region of North America: Geol. Soc. America Bull., v. 80, no. 10, p. 1903-1922, illus., tables, 1969.

In an investigation of paleotemperatures of the sea in which the Pierre Shale of Late Cretaceous age was deposited, the oxygen and carbon isotopic composition of the pelecypod *Inoceramus* and of the cephalopod *Baculites* were found to be different, even in specimens that came from the same locality. The difference in the oxygen isotope composition between these two mollusks is interpreted as the result of metabolic fractionation by the pelecypods. The oxygen isotope compositions of the inocerams and some of the baculites are so light as to indicate temperatures greater tha 30°C, which is too high for mollusks to tolerate. The results of this study do not encourage isotopic analysis of North American climates in Late Cretaceous time. —HMB

Traill, R. J. *See* Ribbe, P. H. 04904

Trautz, O. R. *See* LeGeros, R. Z. 04749

04581 **Traverse, A.; Ames, H. T.** (compilers). Catalog of fossil spores and pollen—V. 31, Mesozoic and Cenozoic spores and pollen: University Park, Pa., Pennsylvania State Univ. Palynol. Labs., 326 p., illus., 1969.

This volume contains protologs for 146 new species and five new infraspecific taxa, as well as descriptions of 22 new genera or form genera and five emended genera. These were originally described in eight publications, with dates from 1960 to 1964, on Mesozoic and Cenozoic spores and pollen from Siberia, China, Austria, Hungary, Australia, and Canada. In the paper on Canadian material (Pocock, 1962), 39 new species and one new variety (including six species of acritarchs and related protistans) were described from Jurassic-Cretaceous boundary strata in the western plains (Saskatchewan and Alberta); these were assigned to 30 genera, of which four

were new, *Cooksonites*, *Januasporites*, *Pflugipollenites*, *Rouseisporites*, and one emended, *Vittatina*. —VMJ

Travesi, A. *See* Peterson, S. F. 04618

04758 **Trettin, H. P.** Pre-mississippian geology of northern Axel Heiberg and northwestern Ellesmere Islands, Arctic Archipelago [with French abs.]: Canada Geol. Survey Bull. 171, 82 p., illus., tables, geol. maps, 1969.

Results of geological reconnaissance and related petrographic studies of parts of the lower Paleozoic Franklinian eugeosyncline and its metamorphic basement are recorded. Lower Cambrian or older metamorphic Cape Columbia Complex is exposed in a fault-bounded uplift; weakly metamorphosed, unfossiliferous sediments, carbonates, chert, and volcanics are probably Cambrian and Ordovician. The nearly complete Silurian to Devonian section consists of >30,000 feet of predominantly clastic and minor volcanic strata representing nonmarine, littoral, shelf, and submarine slope environments. Sediments and siltstones were produced partly by volcanism, but mainly by uplift and erosion and redeposition. Indications are that the adjacent ocean region was elevated in Early Silurian; orogenies occurred between late Proterozoic and Mississippian times; intrusion of quartz diorite took place 360 ± 25 m.y. ago. —*from* Author's abstract

04771 **Tricart, J.** Cartographic aspects of geomorphological surveys in relation to development programmes, *in* World cartography, V. 9: New York, United Nations Dept. Econ. and Social Affairs (ST/SOA/Ser. LI/9), p. 75-83, illus., 1969.

The Commission of Applied Geomorphology has set up the following criteria for geomorphological maps: inclusion of morphometric data, structural data to show geological context in which the forms have developed, morphodynamic aspect to indicate processes that are shaping or have shaped each form, and age of the forms and of surface formations associated with them. Practical applications of geomorphological maps are: (1) indirect—pedology and water resources; (2) direct—agronomy, public works and town planning, and place of geomorphological surveys in programming. —MCM

Trotter, J. *See* Drummond, A. D. 04364

Truchan, M. *See* Collette, B. J. 04727

Tryggvason, Eysteinn. *See* Jam L., Pedro. 04712

04781 **Tullos, Frank N.; Reid, Alton C.** Seismic attenuation of Gulf Coast sediments: Geophysics, v. 34, no. 4, p. 516-528, illus., tables, 1969.

Measurements of seismic energy attenuation have been obtained from normally layered Gulf Coast sediments. Measurements in the low velocity layer were made with individually cemented geophones while all other measurements were made with a cemented array of geophones. Attenuation was found to vary exponentially with frequency to the first power in the range from 50 to 400 Hz. The 1,000-ft deep section measured, made up largely of clay and sand layers, was separated into four sections at depths of 10, 100, and 500 feet. Attenuation in db per wavelength was found to be 13.1, 0.1509, 0.3641, and 0.2004 in the respective sections. —GV

04847 **Turekian, K. K.** The oceans, streams, and atmosphere, Chap. 10 *in* Handbook of geochemistry, V. 1 (K. H. Wedepohl, editor): Berlin and New York, Springer-Verlag, p. 297-323, illus., tables, 1969.

An attempt is made to bring together the most recent data on the chemical properties of the ocean, streams, and the atmosphere. In addition to the chemical data, estimates of the physical properties of the systems are included, such as the dimensions of the ocean basins and the mean annual runoff of the world, since most geochemical calculations involving the cycles of the elements require flux rates and reservoir dimensions for meaningful material balances. —*from* Author's introduction

04612 **Uken, Ernst A.; Santos, Gabriel G.; Walnerdi, Richard E.** Geochemical surveying by means of neutron activation analysis with possible applications to continental drift studies, *in* Modern trends in activation analysis, V. 1—Internat. Conf., Gaithersburg, Md., 1968, Proc.: U.S. Natl. Bur. Standards Spec. Pub. 312, v. 1, p. 367-378, illus., tables, 1969.

A possible technique to indicate just how the world's land masses were connected before continental drift occurred and when they split apart would be to compare elemental abundances of supposedly contiguous regions with areal mapping of continuity of trace-element occurrences. It has been shown by others that a suitable way to determine similarity of rocks is by study of 'metallogenic provinces', that is areas characterized by conspicuous concentration of a certain element or group of elements. It is suggested here that activation analysis be applied to geologic mapping procedures. The Enchanted Rock Batholith near Llano, Texas, was chosen for an experimental study of this technique; the similarity of elemental trends resulted in mapping of nearly concentric zonal arrangement of various rock types. Any unusual or anomalous trends could have been easily detected. —VSN

Umans, H. J. L. M. *See* Das, H. A. 04634

Untermann, B. R. *See* Untermann, G. E. 04757

04757 **Untermann, G. E.; Untermann, B. R.** Popular guide to the geology of Dinosaur National Monument: Dinosaur, Colo.. Dinosaur Nature Assoc., 126 p., illus., 1969.

Dinosaur National Monument lies along the eastern part of the Uinta Mts. in northern Utah and Colorado. Folding and uplift began in Late Cretaceous and continued to recur at intervals during the Tertiary; maximum elevation probably occurred in late Eocene, when uplift was accompanied by large-scale faulting. Along the courses of the Green and Yampa Rivers are four deep canyons: Lodore, Whirlpool, and Split Mtn. on the Green River, and Yampa Canyon on the Yampa River. Rock formations range upward in time from Precambrian (Uinta Mtn. Group) to Cretaceous (Mancos Shale); the Tertiary Browns Park Formation occurs erratically at some higher elevations. The area is a classic textbook of sedimentary deposition and erosion, a fascinating chapter in history for paleontologist or student of fossils, and a combination of unusual landforms and colorful arrays for the visitor. —MCM

04821 **Vagvolgyi, A.; Hills, L. V.** Microflora of the Lower Cretaceous McMurray Formation, northeast Alberta: Bull. Canadian Petroleum Geology, v. 17, no. 2, p. 154-181, illus., tables, 1969.

A section of the Lower Cretaceous McMurray Formation and basal Clearwater Formation has been examined for microflora. The recovered assemblage consists of 58 genera and 94 species of spores and pollen, one species of megaspore perispore, and 5 genera and 7 species of dinoflagellates. One species, *Tsugae pollenites radiostriatus*, pollen is proposed as new. An Early to early Middle Albian age is indicated for the McMurray Formation in the type well. The studied section has been subdivided into two zones: lower, containing only pollen and spores, and upper, containing microplankton as well. Distribution of microplankton indicates a continental origin for most of the McMurray. Distribution of palynomorphs within the core indicates a progressive decrease in species content upwards, interpreted as the result of climatic changes brought about by the advancing Boreal Sea. —*from* Authors' abstract

vanAndel, Tjeerd H. *See* Swindle, George. 04674

04817 **vanGroos, A. F. Koster; Wyllie, P. J.** Melting relationships in the system $NaAlSi_3O_8$—NaCl-H_2O at one kilobar pressure, with petrological applications: Jour. Geology, v. 77, no. 5, p. 581-604, illus., tables, 1969.

Phase relations in the system $NaAlSi_3O_8$-NaCl-H_2O probably are ternary between 850°C and 950°C at 1 kb. A two-phase field of NaCl-rich liquid and H_2O-rich vapor extends into the ternary system. Wide miscibility gaps exist in the $NaAlSi_3O_8$-$1\frac{1}{2}O$ and $NaAlSi_3O_8$-NaCl subsystems. A temperature minimum lies on the ternary liquidus at 873 ± 5°C, and represents the reaction: Albite - $Fluid_{(water\text{-}NaCl)}$ =

Liquid$_{ppss}$. NaCl passes preferentially into the vapor or fluid phase. Chlorine increases the solubility of H_2O in silicate melts. Coexistence of H_2O-rich liquid inclusions and NaCl-rich liquid inclusions in crystals in igneous rocks may indicate pressures less than 1 kb when the inclusions were captured. —*from* Authors' abstract

04638 **VanLoan, Paul Ross.** An X-ray crystal structure determination of aenigmatite [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 314B, 1969.

vanRaaphorst, J. G. *See* Das, H. A. 04634

VanSickle, Gordon H. *See* Gott, Garland B. 04453

04435 **VanSicien, DeWitt C.** A depositional model of Late Paleozoic cycles on the Eastern shelf, *in* Cyclic sedimentation in the Permian Basin—Symposium, Midland, Tex., 1967: West Texas Geol. Soc. Pub. 69-56, p. 17-27, illus., 1969.

Regressive sediments of the Pennsylvanian and Permian major cycle were deposited as a westward-advancing embankment. Within this mile-thick section occur tens of large cycles, each a few hundred feet thick, which contain hundreds of small cycles tens of feet thick. The typical cycle began when a rise in relative sea level terminated the arrival of clay and sand, clearing the water and enabling lime-secreting organisms to thrive. As the terrestrial drainage system regraded to the higher base level a new small-scale embankment of clay and sand advanced onto the drowned shelf to produce the small cycle. Renewed transgression interrupted many of the cycles before this stage was attained, so that a number of limestone bodies hundreds of feet thick were able to accumulate over drowned shelf edges, giving rise to the large cycles. —*from* Author's abstract

VanTrump, George, Jr. *See* Mendes, R. V. 04733

04483 **Varnes, David J.; Kiersch, George.** (editors). Reviews in engineering geology, V. 2: Boulder, Colo., Geol. Soc. America, 350 p., illus., tables, 1969.

This volume contains nine review articles (cited separately) on various aspects of engineering geology. Three deal with land subsidence, one with geocryology, two with cements, and one each with clays as sealants, pedology, and foundations. —HRC

Vaughn, W. W. *See* McCarthy, J. H., Jr. 04955

04356 **Veblen, D. R.; Burnham, C. W.** The crystal structures of hedenbergite and ferrosalite [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 147, 1969.

Vespignani-Balzani, Gian Carla. *See* Fabbri, Bruno. 04767

04935 **Vezzoli, Gary C.; Dachille, Frank; Roy, Rustum.** Sulfur melting and polymorphism under pressure—Outlines of fields for 12 crystalline phases: Science, v. 166, no. 3902, p. 218-221, illus., tables, 1969.

The polymorphism of sulfur has been investigated by static and dynamic methods up to 500°C at 35 kilobars and up to 350°C at 100 kilobars. The melting curve of sulfur to 31 kilobars and phase boundaries of the so-called "4.04-angstrom phase" have been determined. Evidence has been obtained for phase fields of nine new high-pressure forms of sulfur. —Authors' abstract

Vicat, J. *See* Perrault, G. 04383

04743 **Virginia Div. Mineral Resources.** Natural features caused by a catastrophic storm in Nelson and Amherst Counties, Virginia: Virginia Minerals, spec. issue, 20 p., illus., 1969.

Torrential rains of hurricane Camille dumped 27 in. of water during the night of August 19-20, 1969, on portions of Nelson, Amherst, and adjoining counties. All affected streams are in the James River basin; flood damage extended through

Richmond, eastward. Massive landslides of debris-avalanche type moved soil, boulders, and trees to create chutes and channels that extend from the foot of the mountain slopes to mountain crests. Slides were most numerous on mountainsides underlain by the Lovingston Formation, a Precambrian biotite granite gneiss. Alluvial, rubble, and debris fans were formed. Erosional and depositional features are similar to those of 1949 when rainfall developed chutes and channels largely on the Devonian Hampshire Formation. Severe storms are an important factor in erosion and formation of the central Appalachian mountain landscape. Eighteen pages of photographs comprise most of the report. —MCM

Voight, B. *See* Douglass, P. M. 04862

04760 **Voight, Barry; Taylor, J. W.; Voight, J. P.** Tectonophysical implications of rock stress determinations: Geol. Rundschau, v. 58, no. 3, p. 655-676, illus., 1969.

Knowledge of spatial variations (of both magnitude and orientation) and temporal variations of the stress tensor at various points in the Earth's crust is crucial to our understanding of the fundamental nature of tectogenesis. The newly-developed field of endeavor concerned with in-place measurement of stress is expanding, with rapid advances in techniques, personnel, and acquisition of data. Although primarily motivated by engineering and mining operations, the geologic implications—thus far largely ignored—appear to be enormous. Stress determinations have been made on every continent. This paper emphasizes the geologic and geophysical relevance of current stress measurement work, which imposes conditions with which adequate theories of tectogenesis must comply. —DBV

Voight, J. P. *See* Voight, Barry. 04760

Vondra, Carl F. *See* Johnson, Gary D. 04810

04429 **vonHuene, Roland E.; Shor, George G., Jr.** The structure and tectonic history of the eastern Aleutian Trench: Geol. Soc. America Bull., v. 80, no. 10, p. 1889-1902, illus., table, 1969.

A Pliocene age for development of the eastern Aleutian Trench is estimated from the thickness of deep oceanic sediment that accumulated after the trench began to fill. Depression of the eastern Aleutian Trench diminished or virtually ended soon after the trench began to fill. The nearly horizontal, undeformed fill provides no evidence for a large thrust fault zone at the base of the continental slope. Nor is there any evidence that oceanic sediments have disappeared beneath the continents in late Tertiary time. These observations are difficult to reconcile with the simple model of a continental margin advanced in the hypothesis of plate tectonics. —*from* Authors' abstract

04903 **Vozoff, Keeva; Cantwell, Thomas; Mebane, William M.** Magnetotellurics provides a useful new tool for petroleum hunters: Oil and Gas Jour., v. 67, no. 37, p. 66, 68, 70, 72, 77-78, 80, illus., 1969.

Magnetotellurics (M-T), a geophysical method of measuring the electrical properties of rocks, provides a crude electric log, grossly smoothed, obtained from the Earth's surface. M-T is most effective in detailed exploration in two kinds of situations: those where no seismic records are obtainable, and those where velocity contrasts are insufficient for seismics to be effective. In areas where seismics do work, and are available, it is difficult to justify the use of M-T, since costs are roughly comparable, and seismics have far better resolution. An example is cited of the application of this method in the Texas coastal plain. —HHA

04849 **Wager, Robert E.; Podolsky, T.; Alcock, Richard; Weiblein, P. W.; Phinney, W. C.** A comparison of the copper-nickel deposits of Sudbury and Duluth basins [abs.], *in* Mining Symposium, 30th Ann., and AIME, Minnesota Sec., 42d Ann. Mtg., Duluth, Minn., 1969: Minneapolis, Minn., Univ. Minnesota, School Mineral and Metall. Eng., p. 95-96, 1969.

Wainerdi, Richard E. *See* Uken, Ernst A. 04612

04357 **Wainwright, J. E.** Reinvestigation of the crystal structure of gillespite [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 148, 1969.

04521 **Waller, T. H.** Lower Cisco carbonate deposition in north-central Texas, *in* A guidebook to the Late Pennsylvanian shelf sediments, north-central Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 34-39, illus., table, 1969.

Thirteen limestones comprise 7 to 15 percent of the lower Cisco sequence in Stephens County; the limestones average three feet thick. Nine carbonate facies and several related local facies are recognized, based on skeletal constituents and mud matrix. Depth was not a critical controlling factor, but rather turbidity, turbulence, and water circulation. Three interrelated depositional systems are recognized: (1) open shelf, (2) delta (during destruction), and (3) interdeltaic (embayed). The shelf limestones are maximum upslope transgressive tongues of relatively continuous shelf edge limestone sequences, transgressing and regressing as a function of the amount of delta building or destruction. A table shows the environmental factors involved in the different facies. —HRC

04870 **Wampler, J. M.; Smith, D. H.; Cameron, A. E.** Isotopic comparison of lead in tektites with lead in Earth materials, *in* Geochemistry of tektites—Internat. Tektite Symposium, 3d, Corning, N.Y., 1969: Geochim. et Cosmochim. Acta, v. 33, no. 9, p. 1045-1055, illus., tables, 1969.

Lead from moldavites and from Ries glass is isotopically similar; it resembles lead in oceanic sediments and falls on the growth curves typical of most terrestrial rock and ore lead samples, as does lead in all other tektite groups except the Ivory Coast tektites. High U/Pb ratios were found in all tektites analyzed while lower ratios were found in the impact glasses. Lead samples from a bediasite and a Georgia tektite are isotopically the same and similar to other tektite groups (except Ivory Coast tektites). —GV

04474 **Wanless, Harold R.** Eustatic shifts in sea level during the deposition of Late Paleozoic sediments in the central United States, *in* Cyclic sedimentation in the Permian Basin—Symposium, Midland, Tex., 1967: West Texas Geol. Soc. Pub. 69-56, p. 41-54, illus., table, 1969.

During the Middle and Late Pennsylvanian, marine transgressions spread from the southwest along two separate routes: (1) north across Nevada to the Dakotas; and (2) east across southern Arizona, then north through Texas, through Missouri to the Illinois basin, and at times across northern Ohio to the northern Appalachians. Sediments of each marine transgression are put into distinct cyclothems. When studied regionally, the cyclothem contains as many as six or seven deltaic wedges resulting from local influxes of clastic sediment. They are generally tectonically controlled, and interrupt rather than cause the cyclic pattern. These widespread shifts in sea level seem to result from eustatic shifts in sea level simultaneously affecting many separate basins. Their causes may be the alternate growth and waning of Gondwana glaciers, or large scale tectonics in any part of the world. —*from* Author's abstract

Warner, R. O. *See* Sharp, B. J. 04620

Warnock, J. E. *See* Smith, R. B. 04730

Wasserburg, G. A. *See* Zartman, Robert A. 04588

04987 **Watson, Richard A.** Explanation and prediction in geology: Jour. Geology, v. 77, no. 4, p. 488-494, 1969.

Countering arguments of Leopold and Langbein (1963), Simpson (1963), and Krauskopf (1968), the author holds that the seeming randomness and indeterminacy in the development of geologic features and events is due only to our lack of full knowledge of all the microconditions and factors involved. Thus the science of geology does not differ essentially from other sciences. —REW

04980 **Watt, W. Stuart.** An investigation of the Tertiary basalts in Scoresby Sund, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 57-58, 1969.

About 1900 m of the upper part of the basalt succession in this area was studied. The basalts have a general dip of 1° southwesterly so that the highest part of the section should be exposed on the higher nunataks about 50 km south of the inner part of Gaasefjord. In general terms, the basalts are divisible into two main groups according to the amygdule minerals present. Pyroclastics are rare. A single sandstone horizon containing fossil wood was found in one of the basalt sections, but no coal is present. —HRC

Wayhan, D. A. *See* McCaleb, J. A. 04710

04358 **Webber, G. R.** Mercury in two intrusive complexes, Rougemont and Lake Dufault, Quebec [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 148, 1969.

Webber, P. J. *See* Andrews, J. T. 04803

Wechter, M. A. *See* Case, D. R. 04616

04838 **Wedepohl, K. H.** (editor). Handbook of geochemistry, V. 1: Berlin and New York, Springer-Verlag, 442 p., illus., tables, 1969.

In this first volume of a two-volume compilation of geochemical data, the fundamental principles of geochemistry, geophysics, and cosmochemistry are summarized by various authors. The separate chapters are cited in this bibliography under the individual authors. The second volume will be issued in four installments, of which the first has been published; the installments consist of separate chapters for each element (except the noble gases, the lanthanides, and the platinum elements), numbered by the atomic number of the particular element. —MS

04844 **Wedepohl, K. H.** Composition and abundance of common igneous rocks, Chap. 7 *in* Handbook of geochemistry, V. 1 (K. H. Wedepohl, editor): Berlin and New York, Springer-Verlag, p. 227-249, illus., tables, 1969.

Nomenclature and criteria for defining rock types are discussed, and average abundance and compositional values are derived for intrusive and volcanic rocks on the basis of modal analyses and average rock compositions reported in the literature. Data from most sources show agreement on abundance of granitic (85-88 percent) and gabbroic rocks (7-13 percent). Volcanic rocks are of subordinate and local occurrence in the crust and should be excluded from estimations of igneous rock abundances. Tholeiitic basalts are the most abundant; volcanic rocks other than basalts and andesites constitute only about one percent of the total. Recommended rock terms are listed, with information on synonyms and proportions and special characteristics of dark minerals. Tables show averages for various rock types, areal distribution of specific intrusive types, and a tentative standard section of intrusive rocks of upper continental crust. —MS

04845 **Wedepohl, K. H.** Composition and abundance of common sedimentary rocks, Chap. 8 *in* Handbook of geochemistry, V. 1 (K. H. Wedepohl, editor): Berlin and New York, Springer-Verlag, p. 250-271, tables, 1969.

Clastic sediments and sedimentary rocks (including pyroclastic deposits) and chemical and biochemical sediments and sedimentary rocks form the two main groups for which tabulated data on grain size, nomenclature, and rock composition are reported. A table for clastic deposits characterized by specific chemical constituents (such as calcareous clays) or organic residues (such as siliceous clays) and tables reporting the average chemical composition of selected sedimentary rocks and the abundance of sedimentary rock types are also included. —MS

Wedow, Helmuth, Jr. *See* Hill, William T. 04562

04576 **Wedow, Helmuth, Jr.** Models of mineralized solution-collapse structures from drilling statistics [abs.]: Econ. Geology, v. 64, no. 3, p. 353, 1969.

04508 **Weed, S. B.; Philen, O. D., Jr.; Leonard, R. A.** X-ray emission spectroscopic determination of potassium in sub-milligram mica samples after sample treatment: Soil Sci. Soc. America Proc., v. 33, no. 2, p. 318-320, illus., tables, 1969.

Potassium in submilligram-size samples of mica was satisfactorily determined by a thin-specimen, X-ray emission technique. The method utilizes Ti in the sample as an internal standard and involves the determination of the ratio KKα/TiKα. The technique provides a rapid and accurate means of determining K as a function of sample treatment, provided that the Ti content of the sample does not change. —Authors' abstract

04915 **Weeks, Warren B.** Hubert Eugene Bale (1898-1969): Am. Assoc. Petroleum Geologists Bull., v. 53, no. 9, p. 2009, portrait, 1969.

Weiblein, P. W. *See* Wager, Robert E. 04849

04492 **Weidick, Anker.** Investigations of the Holocene deposits around Jakobshavns Isbrae, West Greenland [with French and Russian abs.], *in* The periglacial environment, past and present (T. L. Péwé, editor)—Internat. Assoc. Quaternary Research, 7th Cong., Alaska, 1965: Montreal, Quebec, McGill-Queen's Univ. Press, p. 249-262, illus., 1969.

The fluctuations of Jakobshavns Isbrae during the period from 1850 to 1964 AD have been summarized, and it seems that the altitudinal difference in surface levels of the glacier are in better accordance with the climatic fluctuations than are the frontal fluctuations of the glacier. Fluctuations in the surface level of the Nunatap tasia Lake are treated in conjunction with the fluctuations of the glacier. Two perhistorical stages of the front of Jakobshavns Isbrae have been found. One has a minimum age of 2,500 years BP and formed at a sea level near the present one. The other stage is represented by marine levels between 35 and 80 m above the present sea level. This stage is considered to have an age of Upper Dryas or Lower Boreal.—Author's abstract

Weidler, Jay B. *See* Paslay, Paul R. 04908

04793 **Weiss, Martin.** Considerations in developing storage-retrieval systems for marine geoscience data: Geoscience Inf. Soc. Proc., v. 1, p. 54-58, 1969.

A basic geologic sampling-index form is used to code oceanographic data by the National Oceanographic Data Center. New as well as old data are entered according to these forms even though the older data are commonly less complete. Important advances have been made recently in position and depth determination; the occurrence of such data must always be monitored. The information system must be able to handle information obtained by new techniques, and nomenclature for reporting data should be standard. As this information system develops, it is expected that the originators of data will provide material that is increasingly compatible with the system. —Author's abstract

Wendland, Wayne M. *See* Bryson, Reid A. 04825

04982 **Wenk, Edward, Jr.** The physical resources of the ocean: Sci. American, v. 221, no. 3, p. 167-176, illus., 1969.

The physical resources are summarized in this semipopular article. Estimates of reserves and production are given for many commodities. The coastal margin itself must be recognized as a perishable resource and carefully managed to reverse the trend toward single-purpose use for short term advantages. —DWR

04854 **Went, F. W.** Fungi associated with stalactite growth: Science, v. 166, no. 3903, p. 385-386, illus., 1969.

A fungus, Cephalosporium lamellaecola, was found to be regularly associated with the active tip of stalactites; crystallization of $CaCO_3$ occurred on hyphae suspended from the stalactite wall in the terminal drop. —Author's abstract

04518 **Wermund, E. G.; Jenkins, W. A., Jr.** Late Pennsylvanian Series in north-central Texas, *in* A guidebook to the Late Pennsylvanian shelf sediments, north-central Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 1-11, illus., table, 1969.

Mechanical and sample logs from over 2500 wells in 25 counties are used in the study. Twenty-two nearly isochronous stratal units are recognized. Small scale structural and lithofacies maps of the Missourian, and a lithofacies map of the Virgilian have resulted. Analysis of the various units is made as a part of the framework of the regional studies to follow; the various tectonic elements of the region are described briefly. The dip of all of the rocks is generally westward with only small irregularities, the dip being commonly less than one degree. Five facies can be identified in the outcrop belt. —HRC

04519 **Wermund, E. G.** Late Pennsylvanian limestone banks—A resumé, *in* A guidebook to the Late Pennsylvanian shelf sediments, north-central Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 12-20, illus., table, 1969.

Surface exposures and 22 intervals in 2500 wells were mapped and interpreted. The major components of the limestone banks are platy or phylloid algae and fenestrate bryozoans; other types of plants and invertebrates are present in varying proportions. Certain assemblages can be related to lithology, such as limestone, marl, and shale. The bank limestones are composed of abundant allochems (bioclasts), skeletal organic remains in various stages of comminution; they are in general poorly sorted. In the cores are arenites, rudites, and lutites cemented by 2/3 micrite and 1/3 sparite. The banks are elongate biostromes with local bioherms and generally overlie sandstone or fossiliferous mudstone. Small scale maps show their composition and distribution. Five different possible origins are cited and discussed. —HRC

04522 **Wermund, E. G.; Poort, Jon M.** Field trip, first day, *in* A guidebook to the Late Pennsylvanian shelf sediments, north-central Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 40-51, illus., 1969.

The first day of the trip is between Dallas and Graham, and makes five stops. The stops include neritic limestone bank facies, transition of the bank facies into terrigenous rocks, bank limestones distant from the bank core, the Winchell Limestone south of the Brazos River, and the micritic bank facies. All are Pennsylvanian in age, and each stop is extensively discussed; no accounts of the mileage or geological observations enroute are included. —HRC

Wermund, E. G. *See* Dallas Geological Society. 04539

04947 **Werts, Larry.** Mineral exploration in New Mexico, *in* Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, p. 7-24, illus., 1969.

Uranium and copper are the most important metallic minerals produced in the state; to meet the anticipated demands of the future, exploration geologists will need to become scientists rather than prospectors. Some of the new electronic devices should be used in conjunction with good geological work rather than alone. The best techniques remain the knowledge of the occurrence of materials and the investigation of similar environments in other places. Pasteur could well have been talking about mineral exploration when he said "Chance favors the prepared mind"; so does discovery. —*from* Author's conclusions

04975 **Westergaard, Agnette S.** The border pegmatites of the Ilímaussaq intrusion, *in* Report of activities, 1968: Grönlands Geol. Undersögelse Rap. 19, p. 39-40, 1969.

The northwest boundary of the intrusion is made up of a zone rich in pegmatite. The host rock has a pronounced poikilitic texture and is so similar to the naujaite that it is referred to as such. The whole zone is called the border pegmatite area. At a few places a kakortokita-like rock has been found. The pegmatites in the border occur in a net-like way, the veins being 10-60 cm thick, mainly nonpoikilitic, and contain tabular or prismatic feldspar and other minerals known from the region. The naujaite of the border pegmatite is altered near the lujavrite contact; the contact between the border pegmatite and the lava is sharp. —HRC

04937 **Wetmore, Alexander.** Remington Kellogg, October 5, 1892-May 8, 1969: Soc. Vertebrate Paleontology News Bull. 87, p. 48-49, 1969.

Wheeler, J. O. *See* Hughes, O. L. 04973

04602 **White, Donald S.** Rapid heat-flow surveying of geothermal areas utilizing individual snowfalls as calorimeters: Jour. Geophys. Research, v. 74, no. 22, p. 5191-5201, illus., table, 1969.

Individual heavy snowfalls provide a rapid low-cost means of measuring total heat flow from the ground in hot springs areas. After a favorable snowfall (heavy, brief duration, little wind, air temperature near O°C) contacts between snow-covered and snow-free ground are mapped on a suitable base. Each contact, as time elapses after a specific snowfall, is a heat-flow contour representing a decreasing rate of flow. Values indicated by the method are probably within a factor of 2 of the total convective and conductive heat flow. Thermal anomalies from infrared imagery are similar in shape to heat-flow contours of a test area near Old Faithful geyser. Snowfall calorimetry provides a rapid means for evaluating the imagery and computer-derived products of the infrared data in terms of heat flow. —*from* Author's abstract

White, William B. *See* Poulson, Thomas L. 04668

04494 **Wiggins, Ralph A.; Press, Frank.** Search for seismic signals at pulsar frequencies: Jour. Geophys. Research, v. 74, no. 22, p. 5351-5352, illus., 1969.

This paper reports on an attempt to detect seismic signals at pulsar frequencies by means of the 525-element large aperture array in Montana. Only one possible case of correlation between pulsar frequencies and spectral peaks was found, but the occurrence of nearby spectral peaks with the same or larger amplitude prevents attaching any significance to this apparent correlation without examining a much larger suite of data. The only positive statement that can be made is that if ground motion is excited by gravitational waves originating in the pulsars studied, then the amplitudes are smaller than about 0.01 mμ. —DBV

Wilde, Donald E. *See* Lewis, Christopher J. 04960

04957 **Willard, Max E.** Exploration hypotheses for Luis Lopez mining district, *in* Exploration for mineral resources—Idea Conf., 4th Ann. 1968: New Mexico Bur. Mines and Mineral Resources Circ. 101, p. 126, 1969.

The manganese deposit is at the northern end of the Chupedera Mountains. Earlier studies suggested that the manganese was hypogene and that there may be at depth a change to a barite-fluorite-precious-metal-sulfide deposit which may warrant exploitation. Current mapping shows the minor-element distribution to be unsystematic with little or no systematic variation vertically for 800 feet. Further, the manganese mineralization is now shown to be confined to one rhyolite crystalline tuff. These data suggest that the Mn mineralization, while hydrothermal, is not necessarily epigenetic and derived from some subjacent source, but derived from the volcanics. Volcanic hot springs are a possible source, and if so, no deeper exploration is warranted. —HRC

Willard, R. J. *See* Thill, R. E. 04443

04338 **Williams, H. H.** Chlorine and bromine in carbonate rocks in relation to the chemical history of ocean water [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 148, 1969.

04677 **Williams, Harold; Stevens, R. K.** Geology of Belle Isle—Northern extremity of the deformed Appalachian miogeosynclinal belt: Canadian Jour. Earth Sci., v. 6, no. 5, p. 1145-1157, illus., table, 1969.

Belle Isle is an uplifted block of Precambrian plutonic rocks intruded by northeast-trending diabase dikes and unconformably overlain by Lower Cambrian and earlier(?) sedimentary and volcanic rocks. Diabase dikes are inseparable from the overlying flows but do not penetrate higher sedimentary strata of the southwestern Lower Cambrian succession. Toward the northeast, plutonic boulder conglomerates and quartzites are cut by the dikes. A major anticlinal structure was produced by Paleozoic deformation. The study also shows that on Belle Isle, the Lower Cambrian

of southeast Labrador and western Newfoundland is locally underlain by basalts and conglomerates and quartzites that thicken southeastward and northeastward. —*from* Authors' abstract

Williams, Karl W. *See* Jacka, Alonzo D. 04482

Williams, Loren A. *See* Gilmour, Ernest H. 04514

04927 **Williams, P. M.; Oeschger, H.; Kinney, P.** Natural radiation of the dissolved organic carbon in the northeast Pacific Ocean: Nature, v. 224, no. 5216, p. 256-258, illus., table, 1969.

The natural C-14 activity has been measured in two deep-water samples taken off southern California, in order to determine the "age" of the dissolved organic matter. The "ages" of the samples are 3,470 ± 330 (from 3,300 m at lat 30°15.0′ N., long 119°49.0′ W., on June 18, 1968) and 3,350 ± 300 (from 3,500 m at lat 30°16.2′ N., long 119°49.6′ W., on January 10, 1969); this is significantly older than the ages of inorganic carbon from 2,000 m at similar positions. The fact that the dissolved organic carbon is about 3,400 years "old" in the northeastern Pacific supports the hypothesis that this organic matter, or a large percentage of it, is resistant to biochemical oxidation or bacterial utilization. —DBV

04692 **Williams, Roy E.; Fowler, Phillip M.** A preliminary report on an empirical analysis of drainage network adjustment to precipitation input: Jour. Hydrology, v. 8, no. 2, p. 227-238, illus., table, 1969.

Effect of precipitation on drainage network adjustment and on cumulative stream discharge was analyzed in seven 4th-order drainage basins in each of two till-covered areas. Both areas have similar precipitation intensities and thunderstorm frequencies, but one [Indiana] averages 30 percent greater annual precipitation than the other [Iowa]. Geomorphic parameters determined for each were compared statistically; the number of segments per order per unit area of a 4th-order basin in the wetter area is systematically related to that in the drier. A basin of given order contains more segments of every order in the drier area, but more segments per order per unit area of 4th-order basins occur in the wetter area. Cumulative stream discharge per segment per order per unit area should be greater in the wetter area. The variable other than precipitation, materials and evapotranspiration may be initial relief. —*from* Authors' abstract

04718 **Williams, Roy E.; Allman, David W.** Factors affecting infiltration and recharge in a loess covered basin: Jour. Hydrology, v. 8, no. 3, p. 265-281, illus., 1969.

Hydrographs of shallow piezometers installed in Palouse loess in the Moscow basin, Idaho, reveal local, gravity ground-water systems where the water table fluctuates with precipitation during winter and early spring, as do wells in artesian zones in upper confined aquifers. This suggests recharge by infiltration in and percolation through the loess during the wet season; but surficial layers of silty clay loam planted with wheat act as a major limit to the infiltration capacity of the parent loess, and show the most severe concomitant erosion. On grassy surfaces where rootmats provide optimal conditions for recharge, tests indicate that infiltration rates of four or more inches per hour can be expected, and erosion is minimal. Tubular openings in the loess, extending to depths of 30 feet, often influence measured infiltration rates, their frequency decreasing with depth. Surface conditioning agricultural practices may induce more recharge through these tubes. —GDC

Williams, S. J. *See* Mandarino, J. A. 04375

04449 **Wilson, Charles R.; Forbes, Robert B.** Infrasonic waves from Alaskan volcanic eruptions: Jour. Geophys. Research, v. 74, no. 18, p. 4511-4522, illus., tables, 1969.

Explosive eruptions of Trident Volcano in Katmai National Monument and Redoubt Volcano on Cook Inlet, Alaska, were found by triangulation to be the sources of infrasonic waves received at College and Palmer, Alaska, during 1967 and 1968. The

volcanic infrasonic waves propagated via the lower and upper atmospheric sound channels. For an assumed sound speed of 313 m per sec, the average values of the elevation angles for the infrasound rays were 20° for the lower channel and 43° for the upper channel. The signal velocity from College to Palmer varied from 275 to 289 m per sec, depending on the mesospheric wind structure. —Authors' abstract

Wilson, Edward L. *See* Sandhu, Ranbir S. 04909

04477 **Wilson, James Lee.** Cyclic and reciprocal sedimentation in Virgilian strata of southern New Mexico, *in* Cyclic sedimentation in the Permian Basin—Symposium, Midland, Tex., 1967: West Texas Geol. Soc. Pub. 69-56, p. 82-99, illus., table, 1969.

Virgilian cycles of the Holder Formation in the shelf area on the northeast side of the Pennsylvanian Oro Grande basin contrast lithologically with the cycles in equivalent basinal sediments cropping out to the south and west. Basin cycles begin with cross-bedded sandstone and grade upward through relatively thick shale to a dark tidal flat lime mudstone and shale. Shelf cycles contain a variable sandstone and shale lower member, with local channel-fill conglomerate. This grades upward through normal marine limestone and shale to a massive capping bed of shoal-water lime grainstone of algal-foraminiferal lime mud mound facies. The two sequences may be correlated by considering that sea level fluctuated repeatedly over the whole basin, and that major sedimentation alternated between the shelves and the basin. —*from* Author's abstract

04478 **Wilson, James Lee.** Influence of local structures on sedimentary cycles of Late Pennsylvanian beds of the Sacramento Mountains, Otero County, New Mexico, *in* Cyclic sedimentation in the Permian Basin—Symposium, Midland, Tex., 1967: West Texas Geol. Soc. Pub. 69-56, p. 100-114, illus., 1969.

The La Luz anticline influenced Late Pennsylvanian sedimentation in the Sacramento Mts., New Mex., in the following ways: (1) a shoal area with oolite beds was formed downslope from the shelf area east of the Fresnel-Salada growth fault during Beeman time; (2) influenced development of clean quartz sand on seaward flank in the cycle above the oolite beds; (3) caused a migration of the lower Holder bioherms down its seaward flank; (4) caused more complete oxidation of iron compounds due to subaerial exposure during later cycles; (5) several sedimentary cycles are well developed on opposite flanks of the anticline but disappear across it; (6) the two highest cycles studied represent a transgression which followed upon a disconformable surface, a lag deposit of blackened pellets, ooids, and lithoclasts which cut across the anticline. —KAF

Winchester, John W. *See* Schilling, Jean-Guy. 04802

04699 **Wise, William S.** Origin of basaltic magmas in the Mojave Desert area, California: Contr. Mineralogy and Petrology, v. 23, no. 1, p. 53-64, illus., tables, 1969.

The lavas of the Mojave Desert are basanites, alkali-olivine basalts, and low-alumina, subalkaline basalts. One volcano, Pisgah crater, erupted five times with lava from each successive phase containing more silica and less potash than the one preceding it. This trend is the reverse of that expected from the differentiation of a single alkalic magma, and therefore may represent a succession of magmas tapped from a zone of continuing partial melting in the mantle. The first melting was under high water pressure and was followed by relatively dry partial melting of garnet-orthopyroxene-clinopyroxene-olivine assemblages. The later silica increase and alkali decrease require the partial melting zone to move to shallower levels. Compositions of all lavas sampled are best explained by extraction of magma from such a rising melting zone. —*from* Author's abstract

Witherspoon, Paul A. *See* Neuman, Shlomo P. 04819

Witters, J. *See* Shimp, N. F. 04816

Wittkopp, R. W. *See* Stephens, J. D. 04737

04577 **Wolf, Frederick A.** A rust and an alga in Eocene sediment from western Kentucky: Elisha Mitchell Sci. Soc. Jour., v. 85, no. 2, p. 57-58, illus., 1969.

Nonpetrified teliospores of the rust fungus *Puccinia* and a nonpetrified fresh-water filamentous alga, *Microspora quadrata*, have been found in an Eocene ball clay deposit, overlain by at least 10 feet of alluvial soil, in Graves County, Ky. From the same formation in eastern Tennessee, Dilcher (1965) has described many epiphyllous fungi. No older occurrences of either rust spores or algae in nonpetrified condition are known. The alga retains a pale green color, unlike nonpetrified algae reported from the Green River oil shale (Davis, 1916; Bradley, 1929, 1962). —VMJ

04578 **Wolf, Frederick A.** Nonpetrified fungi in late Pleistocene sediment from eastern North Carolina: Elisha Mitchell Sci. Soc. Jour., v. 85, no. 2, p. 41-44, illus., 1969.

Nonpetrified fungus spores of at least 10 named genera were found in a late Pleistocene lake sediment layer exposed in a marl quarry at New Bern, N.C. The 6-inch layer of sticky black sediment contains many plant fragments and has been C-14 dated at about 24,000 yr; it is overlain by 10 to 12 feet of sandy clay. A species of *Endogone* (= *Rhizophagus*) is found as empty chlamydospores and supporting mycelium. This genus is associated with roots of several hundred modern species of plants and has remained unchanged in morphology since its association with Devonian psilophytes; its apparent lack of host specificity may be attributed to its wide range of enzymes. The spores decomposed rapidly in a block of sediment stored for a short time. —VMJ

Wollitz, L. E. *See* Garber, M. S. 04785

04460 **Wood, Walter A.** The Alaska-Yukon Icefield Ranges Research Project, 1964, 1965, and 1966, *in* National Geographic Society research reports 1964 (Paul. H. Oehser, editor): Washington, D.C., Natl. Geog. Soc., p. 257-261, 1969.

The Icefield Range is 60,000 sq km in area and comprises a major topographic barrier between the marine Pacific and the continental interior environments. Studies of glacier movement were undertaken along with a ground traverse of the St. Elias Mountains, the objective being to obtain data for assessing hydrological conditions across the glaciers of the Icefield Range. The movements of the Kaskawulsh and Hubbard Glaciers were studied, the regimens examined, and earlier stakes resurveyed. The Steele Glacier was studied while surging in 1966. —HRC

Woodland, Bertram G. *See* Zangerl, Rainer. 04894

Wright, T. L. *See* Grommé, C. S. 04598

Wright, Thomas L. *See* Kinoshita, Willie T. 04855

04339 **Wyllie, P. J.** Phase equilibrium studies bearing on genetic links between alkaline and subalkaline magmas, with special references to the limestone assimilation hypothesis [abs.]: Canadian Mineralogist, v. 10, pt. 1, p. 149, 1969.

Wyllie, P. J. *See* vanGroos, A. F. Koster. 04817

Wyman, J. M. *See* Nichols, R. A. H. 04809

04607 **Young, Bruce Cash.** The geomorphology of the Pinto Basin, southern California [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 251B, 1969.

04529 **Young, Leonard M.** Stratigraphy and sedimentology of the Marathon Formation, *in* A guidebook to the stratigraphy, sedimentary structures and origin of flysch and preflysch rocks of the Marathon basin, Texas—AAPG-SEPM Ann. Mtg. 1969: Dallas, Tex., Dallas Geol. Soc., p. 32-42, illus., 1969.

Isopach and facies data suggest that the depositional basin was elongate from SW-NE, and currents flowed from the east and west margins, and along the axis. The major source of terrigenous material was from the southwest and southeast and con-

tained sedimentary, metamorphic, and igneous rocks. Boulder-beds, thinning toward the southeast, show a similar mixed source to the northwest, dominated by outcrops of supratidal dolomite. The sandstone, siltstone, and calcarenite beds, and possibly some micrites are turbidites from below the surf base. The shale and marl and most of the micrite are from fairly deep water pelagic deposits. The conglomerates are waning-current deposits and may represent a proximal turbidite facies. The boulder beds record at least three periods of Early Ordovician tectonism. —HRC

Young, R. A. *See* Sudarsanan, K. 04869

04570 **Yund, R. A.; Hall, H. T.** Hexagonal and monoclinic pyrrhotites: Econ. Geology, v. 64, no. 4, p. 420-423, illus., 1969.

The sulfur-rich limit of hexagonal pyrrhotite below 290°C is 47.45 atomic percent iron and is independent of temperature. Monoclinic pyrrhotite is metastable above 290°C and may be metastable at lower temperature as well. The composition of monoclinic pyrrhotite seems to be a function of temperature, but experimental determination of its composition also depends on the decomposition rate if it is metastable. The use of the composition of monoclinic pyrrhotite and the hexagonal pyrrhotite solvus for estimating formation temperatures is not justified unless the thermal history of the specimen is known. —*from* Authors' abstract

Zachry, D. L., Jr. *See* Zangerl, Rainer. 04894

04653 **Zakrzewski, Richard Jerome.** The rodents from the Hagerman local fauna, Upper Pliocene of Idaho [abs.]: Dissert. Abs. Internat., Sec. B, Sci. and Eng., v. 30, no. 1, p. 262B, 1969.

04894 **Zangerl, Rainer; Woodland, Bertram G.; Richardson, E. S., Jr.; Zachry, D. L., Jr.** Early diagenetic phenomena in the Fayetteville Black Shale (Mississippian) of Arkansas: Sed. Geology, v. 3, no. 1, p. 87-119, illus., 1969.

Limited exposures of Fayetteville Shale furnished a remarkable variety of concretions, ten of which are described. The relation of fossils to structures and mineral concentrations in most of these concretions illustrates the significance of organic decomposition and the resultant gases in very early diagenesis. Nucleated precursors of concretions developed during the brief time required for biogenic decomposition of animals and their feces. Burial aspects of small goniatite shells and large conchs of the cephalopod *Rayonnoceras* may have resulted from the episodic emplacement of large increments of a thixotropic mud. Absence of matrix within collapsed living chambers of *Rayonnoceras* proves that the carcasses of the animals remained within the shells after burial; instantaneous collapse of living chambers is postulated following escape of gas and expulsion of the decomposing carcasses, without opportunity for the introduction of mud. —Authors' summary

04588 **Zartman, Robert A.; Wasserburg, G. A.** The isotopic composition of lead in potassium feldspars from some 1.0 b.y. North American igneous rocks: Geochim. et Cosmochim. Acta, v. 33, no. 8, p. 901-942, illus., tables, 1969.

The isotopic composition of Pb and U, Th and Pb concentrations in K-feldspars are determined for more than 30 1.0 b.y. old North American rocks; an effort was made to include only rocks having well-documented ages of 950-1140 m.y. with minimal evidence of subsequent metamorphism. Most samples have limited lead isotope variations which yield model ages close to radiometric ages. Several samples with isotopic compositions very different from the above group all involve small intrusions of granite which lie near considerably older areas of basement rock. Several possible interpretations of these results are offered; in particular, a "vertically differentiated crust" model is proposed which will account for both the main spectrum and the anomalous lead. The significance of lead isotopes in studies of continental crustal structure is discussed. —GV

Zodrow, E. L. *See* Harris, D. P. 04709

04784 **Zohdy, Adel A. R.; Jackson, Dallas B.** Application of deep electrical soundings for groundwater exploration in Hawaii: Geophysics, v. 34, no. 4, p. 584-600, illus., tables, 1969.

Forty-five resistivity soundings were made on the islands of Oahu and Hawaii, using the Schlumberger and equatorial dipole electrode configurations, to determine the applicability of direct current resistivity methods for locating fresh water aquifers. Interpretation of 32 sounding curves taken from Oahu indicates that it is possible to correlate five stratigraphic units underlain by a vesicular basalt basement, and that determination of the approximate depth to the fresh-water—saline-water interface within the basalt is feasible. Interpretation of 13 deep soundings made with Schlumberger and equatorial arrays on Hawaii suggest that the minimum depth to a conductive layer, which may represent a basalt saturated with fresh water, is about 2,700 feet below land surface. The ground water appears to be dike impounded.—GV

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